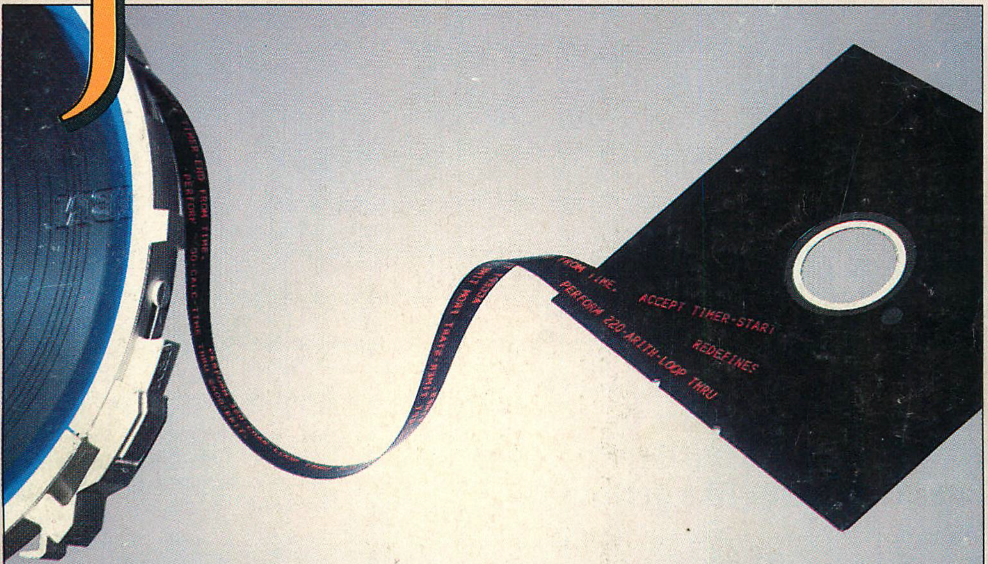
JUNE 1985 VOL. 3, NO. 6 $3.95

FOR IBM PERSONAL COMPUTER USERS

PC TECH JOURNAL



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[redacted]

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Now you won't have to wait for the difficult to find hard-disk version of the IBM AT (model 99). You can buy the floppy disk IBM AT (model 68), add our hard disk and tape drive system for about what you'd pay for the AT hard disk upgrade alone. It's almost like getting the tape drive free.

Let's face it, we've all heard the horror stories of people who've lost data on their hard disk. True, it doesn't happen often, but then disaster seldom does. With the amount of data you can put on a hard disk these days, no one in business can afford even a small disaster.

When did you last backup your hard disk?

Oh, you did it once with floppies and it was so time consuming that now you've convinced yourself nothing will go wrong? In other words, it can't happen to you. And besides, at the prices they're asking for tape backup—$2,000 and up—you're willing to take a chance. You've seen some tape drives for less, but you have to buy an expensive hard disk to go with it, and you've already got a good hard disk. Where can you turn for relief?

IBM Compatible tape drive system complete for $995

The Express Systems™ tape drive comes complete—half-high tape drive, controller, and software—for only $995. It's absolutely IBM compatible—all 60 megabytes of it.

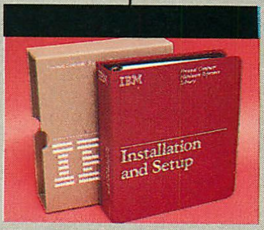
You can use your tape drive in the event your hard disk fails. And if you have to replace your hard disk, the tape's ability to read bad sectors will let you replace your hard disk with another even if the new one is not error-free. The tape requires very low power, too.

And it doesn't poke along. It reads and writes at 90 inches per second (ips) and transfers data at up to 3.75 megabytes per minute in the streaming mode. You don't have to be a rocket scientist to figure that you can perform an image backup of a 20 megabyte hard disk in about 5 minutes. But practically speaking, once you back up your hard disk completely for the first time, you never need to do more than invoke the archive command—that convenient command that tells your new tape drive to back up everything since you last backed up. If you backup as often as you should, your Express Systems tape drive will finish the job virtually in seconds.

The Express Systems software has additional benefits, like enabling you to use PC DOS terminology such as "*", "*.*", and "?". It also has a built-in reformatter, built-in verification (to make sure you transferred what you thought you did), and it's prompt driven, which means it asks you exactly what you want to do.

Easy to install

Before you get intimidated about installing our tape drive internally, you should understand that IBM doesn't think it's too difficult. They're selling IBM PC ATs with instructions on how to add additional hard disks in the *Installation and Setup* manual that comes with the AT.



The IBM AT installation manual shows how easily you can install internal storage drives yourself.

Our instructions for installing your new Express Systems tape drive follow IBM's clear, simple instructions.

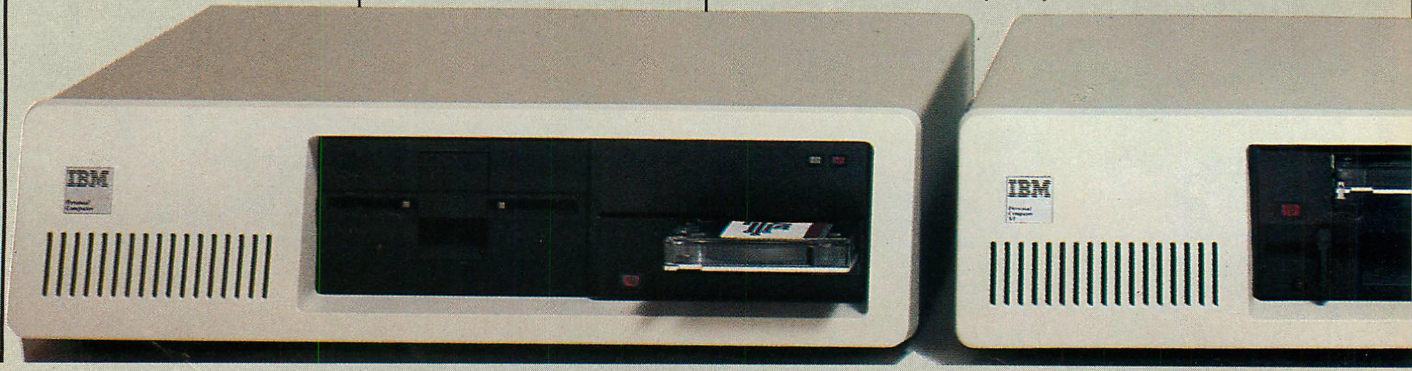
We even provide the tape cartridge

Most people don't realize that the tape cartridge contains most of the critical mechanisms to insure data integrity. In order to be sure that you get the best insurance for your data (after all, isn't that why you're buying it) we encourage you to use Express Systems' specially tested tape cartridges. We're not going to kid you and tell you others won't work, but here's what's special about Express Systems' tape cartridges.

First, they are tested down four separate tracks from end-to-end, not just down the center of the first 150 feet, like some others do. We use three screws to hold the cover on instead of four. This simple triangular arrangement keeps the baseplate flat, just like three legs work better than four to make a table steady. Since all tape drives reference everything to the baseplate, this alignment is critical. We also use special rollers to dissipate posible static electricity buildup—something that can ruin your whole day.

The Express Systems tape drives come with Express Certified™ 555 or 600 1/4-inch tape cartridges with quadruple end-to-end testing for extra insurance of your data.

And finally, we will sell you tape cartridges in boxes of three instead of the usual five. So, you get higher quality with a smaller quantity commitment. And we compound the savings with a lower per unit price, just $35.00 instead of the usual $45.00 most retailers charge.



Need a hard disk?

Depending on whether you have an IBM PC, XT, or AT you may want additional hard disk storage. We have those too. We offer 10, 21 and 31 megabytes of formatted hard disk storage.

For the most part, our drives are made with plated media, which means there is less chance to damage them. (Let's face it, the oxide that most disks come with is nothing more than rust.) We then test the drives, pre-format them, and install DOS 3.0 so that you're ready to begin transferring files. We even include DOS 3.0 documentation.

Express Systems offers 10, 21, and 31 megabytes of formatted storage in the half-high form so you have extra space for other storage options.

And they're 100 percent IBM compatible. The controller we send you for the XT is an upgraded version of the XT controller from the same company that makes the XT controller. In fact, the Express Systems controller is an improved controller which requires less power so that it is more reliable than any other standard controller.

We provide the power too.

f you want to upgrade your BM PC, there just isn't any way around upgrading your power supply—if you want to have true XT or better capability. Some companies say that their hard disks don't require any increase in power—and they might be right. But don't add anything to your slots, because the minute you do, you'll need more power. That's the bad news.

The good news is that our ower supplies are inexpensive. How's $99.50 for an XT power supply? We mean a full 130 watts of power. The other good news is that it's held in by only 4 screws. Express Systems' power supplies can be changed in 20 minutes, a small price in time for the peace of mind to convert your PC to an XT-capable machine and avoid the unsightly "wart-like" power supply add-ons that some companies insist you paste on the back of your PC.

Our 130 watt power will convert your PC to XT standards; and it's only $99.50 with any tape drive or hard disk order.

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But from a mail order house?

We get tired of the snide remarks some people make about mail order houses. The comments are usually spread by distributors and retailers who are getting cut out of 15 and 35 percent margins, respectively. If we went through distribution—you'd have the privilege of paying for large glass windows, rugs, salesmen, etc.—but we'd also be selling this tape drive for $1495.

We're not criticizing distributors and retailers. They perform a valuable service. But you don't need them if you know what you want. And you can certainly install it yourself. IBM has proved it with their instructions for self-installation that come with the new IBM PC AT.

And speaking of IBM, the next time you hear anyone criticize mail order as a way to buy computer equipment, remind them that IBM is now in the mail order business.

Warranty

We offer you a one year warranty on our hard disks—the same as IBM on the AT and 90 days on the tape drives. (It's all the manufacturer gives us.) If anything goes wrong with your tape or disk drive or hard disk, send it back in the box it came in. However, we have found that we can usually solve the problem over the phone. So call first for a return authorization number because we can't accept any returns without it.

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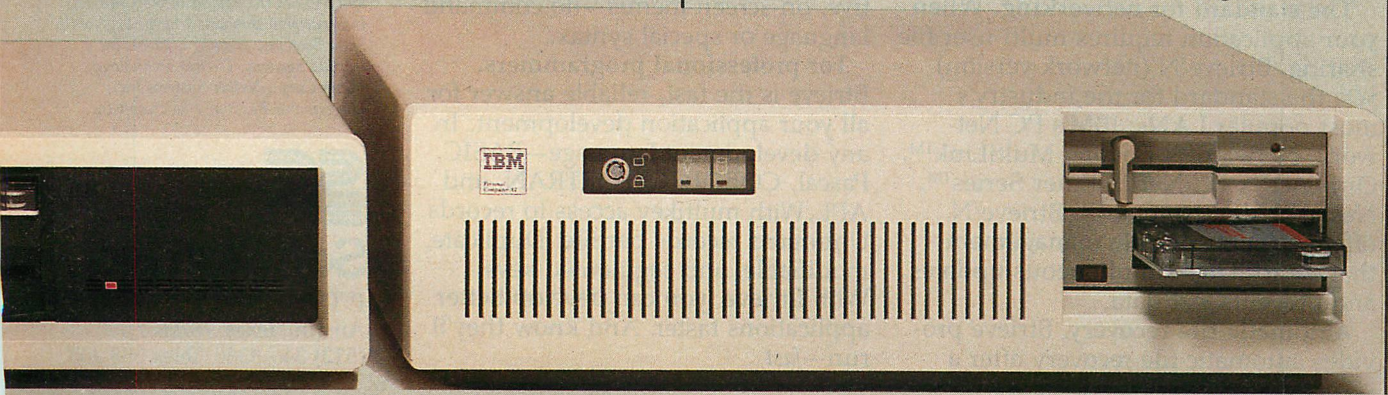

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JUNE 1985

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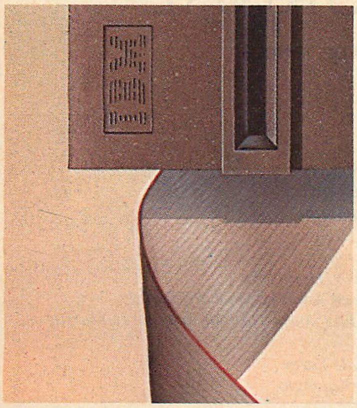
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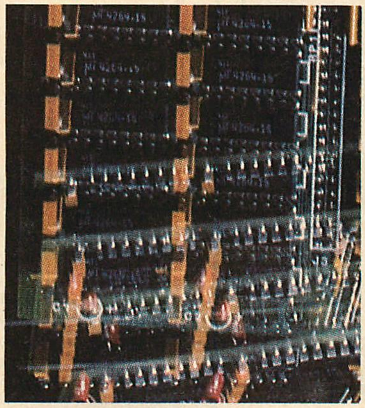
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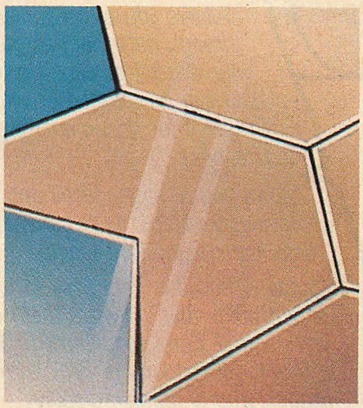
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THE THIRD DRIVE / JACK WRIGHT and DAVID ZARODNANSKY
Three is not necessarily a crowd for floppy-disk drives if permanent on-line program storage is the goal, and a hard-disk drive is not in the budget. External floppy drives can be added to a PC with relatively little expense. 47

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ENCRYPTION SOFTWARE / VICTOR MANSFIELD
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Cover photograph Marc David Cohen

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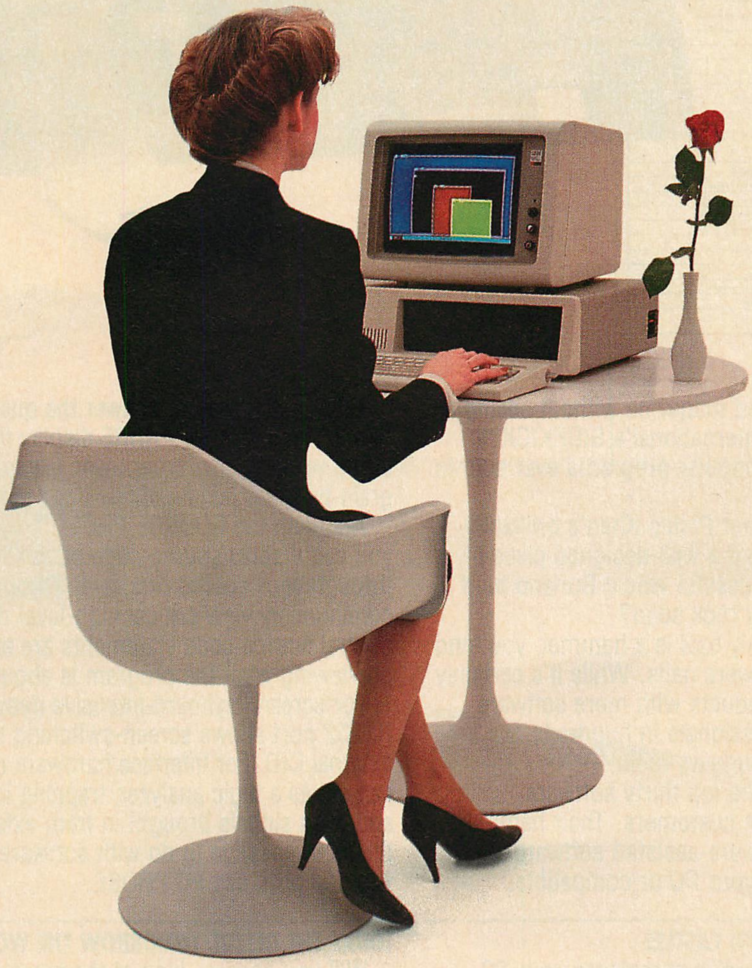

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PC Week/Softsel Top List—December

BUSINESS	
1 1-2-3	Lotus
2 SIDEKICK	Borland International
3 SYMPHONY	Lotus
4 DBASE III	Ashton-Tate
5 MULTIMATE	Multimate International
6 PFS:WRITE	Software Publishing
7 TAX PREPARER 1985	Howardsoft
8 PFS:FILE	Software Publishing
9 WORD PERFECT	Satellite Software
10 MICROSOFT WORD	Microsoft
HARDWARE	
1 SIXPAKPLUS	AST Research
2 HERCULES GRAPHIC CARD	Hercules
3 SMARTMODEM 1200B	Hayes
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7 PRINTWORKS	SoftStyle
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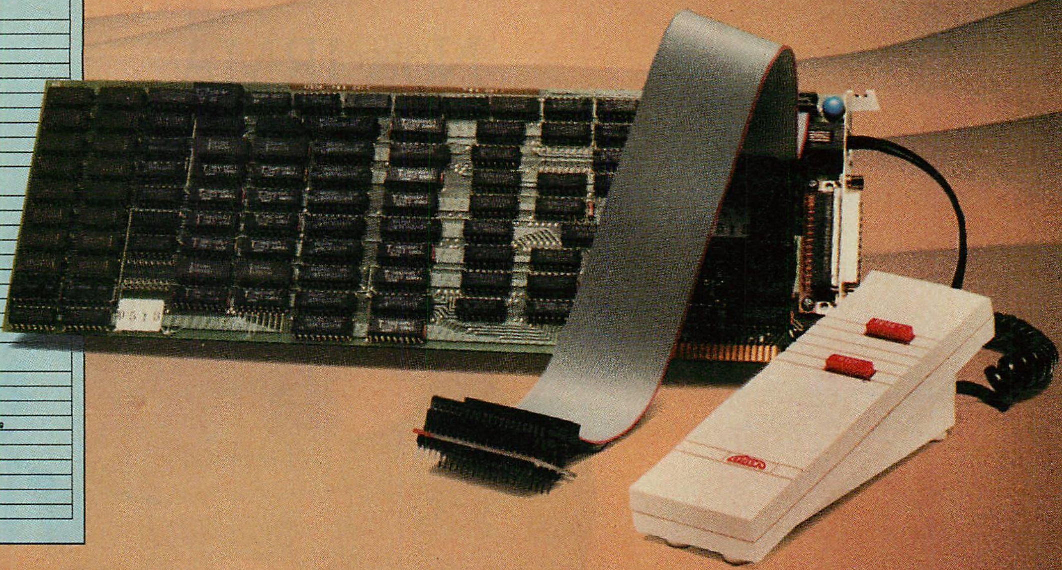

You can't pick up a PC-related magazine without seeing an editorial reference to Borland International's SIDEKICK™ program. It's one of the most popular programs ever sold to PC and PC-compatible users.

FORTUNE magazine talks about Phillip Khan's brilliantly well-executed marketing plan and a well-designed piece of software. All true. But how successful would Borland be if their product weren't absolutely rock solid?

Someone said that if your only tool is a hammer, you tend to treat all problems as if they were nails. While it's certainly possible to hammer out PC products with mere software debuggers, thousands of professionals in hundreds of companies are using Atron debugging tools.

As you can see, thirteen of the top thirty software packages were created by Atron customers. Their hammer: ATRON'S PC PROBE™, a hardware-assisted software debugging tool that plugs into your PC or compatible.

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CIRCLE NO. 203 ON READER SERVICE CARD

Borland Magic

Is the inventor of Turbo Pascal a good model for budding software development companies?

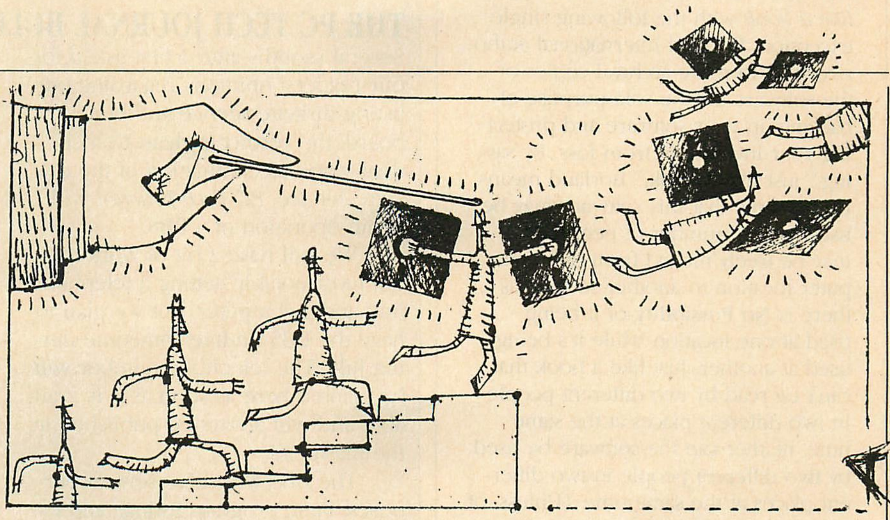


ILLUSTRATION • MACIEK ALBRECHT

The computer business, and particularly the microcomputer business, is replete with legend. We learn some new fact (or fiction) about Steve and Steve's garage every year. There are Gates and BASIC, Bricklin/Frankston and VisiCalc, Kapor and Lotus 1-2-3. There is the Compaq tablecloth . . . or was it a napkin? Oh, and Osborne. And many, many more.

A legend of more recent vintage is good old Frank Borland, that mystical programmer cum prospector who roams the desert, occasionally popping off a piece of software for "the good of mankind." Frank has a lot to say about the computer software industry—and a strong moral sense to go along with his comments. The result of Frank's philosophy is Borland International, a company that has given us more than its share of innovation in its two-year life.

To begin with, there is Turbo Pascal. I do not recall any product in the past four years that has attracted more attention or received more accolades, including *PC Tech Journal*'s own Product of the Month and *PC Week*'s Product of the Year. And that's really unusual: how could a compiler for a programming language attract so much attention and generate such interest? Prior to Borland, estimates for the Pascal market did not exceed 40,000 units, and many of us considered that to be optimistic. Three-hundred-thousand copies later, Borland's founder and president, Philippe Kahn, says he was surprised, too; he believes the market was ready for an alternative to BASIC. I wonder if he thought that all along?

Three-hundred-thousand copies is the kind of success upon which laurels are usually rested. Not at Borland. Frank conjured up SideKick, another winning product. It also represents a fascinating case; a software company rarely shifts market areas so completely and with such success. This is rare not because companies cannot come up with the ideas, but because they are afraid to venture beyond an area in which they have gained confidence and acceptance. A bad product in a different area will not necessarily kill a venture, but it certainly will tarnish it; apparently, most firms are not willing to take the risk. More's the shame, in general, but Borland seems to have seized whatever opportunities presented themselves.

Both Turbo and SideKick represent a daring attitude. Borland took big risks (Kahn says not so, but the memory of JRT Pascal is still a vivid one for many) and they paid off. Some would say that Borland was not so much daring as foolhardy. It's one thing, after all, to offer powerful, sophisticated products in areas either dominated by others or emerging from well-financed start-ups or already successful ventures, and quite another to price the products two movie tickets away from computer games. With the price of Pascal compilers at $295 and up, how could anyone take a $49.95 product seriously?

Price is not the key here; *value* is. The low prices grabbed our attention, but the quality of the goods held it. Daring, yes. Foolhardy, maybe. Innovative? Yes, and refreshing too. Most vendors want to make every last dollar out of each copy sold, for fear that the product soon will fall from favor or become obsolete. Borland, however, seems to feel that keeping the price low while delivering quality will attract customers back for more.

SideKick induced another innovation. Borland suspected that the product would be popular and thus subject to illegal copying. The first version was protected. The user backlash was astonishing—and ugly. Without backing away from its strategy, Borland began to ship unprotected copies of the product, albeit for a $30 (55-percent) premium. Not bad. Do you want cheap? Here it is. Do you want freedom to archive (or whatever)? You've got it—for a few additional dollars. This is a strategy that even satisfies editors, an intractable lot who traditionally do not appreciate copy protection; Borland's review copies are always unprotected.

For Turbo Pascal, protection was achieved in an unusual, although not entirely novel, way. Even though the product is very attractive, it cannot be used easily without a manual. Borland printed a manual *and then bound it like a book*, making it very difficult to copy. Even if a diskette were copied, the illegal user would likely want to purchase a legitimate copy just to have the documentation.

So far Borland has provided daring, innovative, inexpensive, high quali-

ty products with new twists in packaging. Enough? Not for Frank, apparently. In the wake of turgid licensing prose from the likes of IBM and others, Borland adopted something called the "No-Nonsense License Statement!" It is both innovative and dull at the same time, but it is worth noting in full:

> This software is protected by both United States Copyright Law and International Treaty provisions. Therefore you must treat this software *just like a book* with the following single exception. Borland International authorizes you to make archival copies of the software for the sole purpose of backing-up your software and protecting your investment from loss. By saying, "just like a book," Borland means for example that this software may be used by any number of people and may be freely moved from one computer location to another so long as there is **No Possibility** of it being used at one location while it's being used at another. Just like a book that can't be read by two different people in two different places at the same time, neither can the software be used by two different people in two different places at the same time. (Unless, of course, Borland's Copyright has been violated.)

A quick check with contributing editor and attorney Max Stul Oppenheimer reveals that this is tantamount to saying nothing at all, because it is nothing more than a statement of Borland's rights established by the publication of a copyright notice in or on the work. But Oppenheimer also called the statement innovative. That notice says, "We own the software, the rights belong to us, but we understand that you should be able to use it effectively and protect it from loss. Go ahead, do that; just don't abuse your privilege and run roughshod over our rights." All in all, this is a rather pleasant statement—much better than the long ones that spell out everything a user cannot do to or with a piece of software; and a lot better than the black hats out there pressing litigation to set examples.

Borland has had a magical and now legendary effect on the software market. Perhaps most importantly, Borland has set previously unheard of price standards for software of professional quality, and has put severe pressure on the established language vendors. Turbo Pascal has even spawned its own after-market for add-on products. SideKick has been innovative enough to cause other small companies to enter the market and compete directly at the same price, and it has been functional enough to cause sales problems for its more expensive competition. The company is responsive and accessible: customer satisfaction seems to be high. And Borland has offered quick and creative solutions to some difficult industry-wide problems.

Philippe Kahn, ebullient and effervescent as ever, fully expects to duplicate these successes. Turbo versions of other languages are on the way. Products in other market segments, such as the new SuperKey, are planned. There is a new 60-day, money-back guarantee so people will be able to try the new products at no risk.

Don't you wish every software company took Frank's approach and had his attitude? I do.

THE PC TECH JOURNAL BULLETIN BOARD

Several months after I first asked for our readers' opinions regarding our listing diskette service and bulletin board, the verdict is clear. Coincident with the elimination of the diskette service, *PC Tech Journal* will begin operation of a BBS.

We still have a bit of work to do, most notably getting a telephone line and a computer, but we plan to have the BBS on-line sometime during July. The telephone number will be printed here as soon as it is available and will always be published in the masthead.

The BBS will serve several purposes. First, program listings and executable versions of whole programs appearing in our pages will be available for downloading. We will try to keep the last year's worth of listings on-line. Second, we will provide a cumulative index to the magazine in ASCII form. Callers will be able to receive the file and search for what they need with a text editor; the data will be formatted for easy loading into the most popular data management products. Third, our authors will be able to transmit manuscripts or other materials to us. Finally, readers can post messages to us, and we can post messages in return. Messages left on the BBS by callers will be considered publishable letters to the editor.

On the technical side, we expect to provide both 1200 and 2400 service; 300 baud will not be supported. If demand for the system justifies it, we will add phones lines and multiuser capability.

We hope our BBS will add an extra dimension to *PC Tech Journal*, and that you will find it useful.

—*WF*

A SHAKEOUT IN TRADE SHOWS

I just returned from the second SOFTCON show, held this year in Atlanta. I went, and even sent another one of our editors, because the first SOFTCON last year in New Orleans had not only been interesting, but very productive for us as well. Although it was not well attended, SOFTCON '85 was wonderful for those of us in the press because it had a more leisurely pace and the vendors took time to speak with us. Vendors apparently want more than just press and other industry people, however, because this year's show had half the exhibitors and not as many visitors. It is hard to imagine SOFTCON will appear for a third time.

The problem is too many shows, both for vendors and visitors. It's about time we settled on three major national shows: COMDEX (Atlanta) in the spring, the National Computer Conference (Chicago) in the summer, and COMDEX (Las Vegas) in the fall. Supplementing these should be strong shows for specific disciplines (such as NCGA and SIGGraph for graphics).

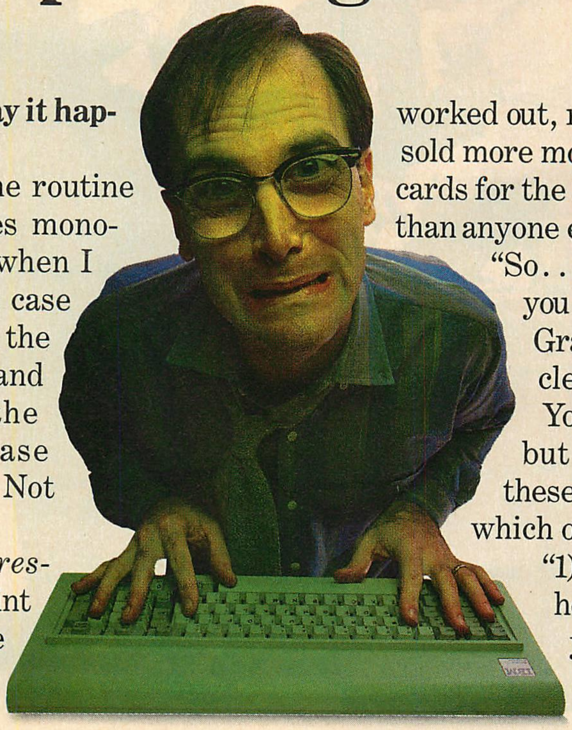
With a reduced number of shows, the biggest might get bigger. The best solution for scheduling might be to run each show for one work week, Monday through Friday, with special events staged on the preceding Sunday, and the conferences slotted earlier in the week.

A larger show is more time- and cost-effective for most visitors (fewer trips, better use of time). Fewer shows also benefit vendors, because they can spend less time worrying about which shows to attend and concentrate on getting the maximum benefit out of the major shows.

I hope the trade show business evens out soon. I know at least one professional show-goer who is getting tired of them.

—*WF*

If you don't have a Hercules Graphics Card, you could end up looking like this:



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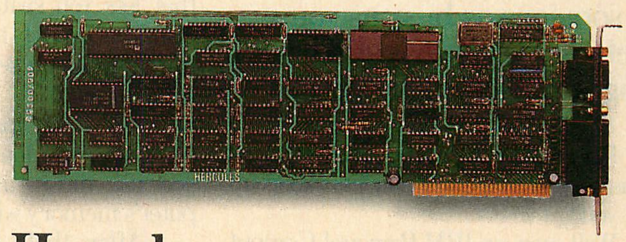

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But simplest of all is a certain "Brand IBM", namely the IBM Assistant Series—for filing, writing, planning, reporting and graphing.

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To learn more, call an IBM marketing representative, or visit an IBM Product Center or Authorized IBM PC or Software Dealer.

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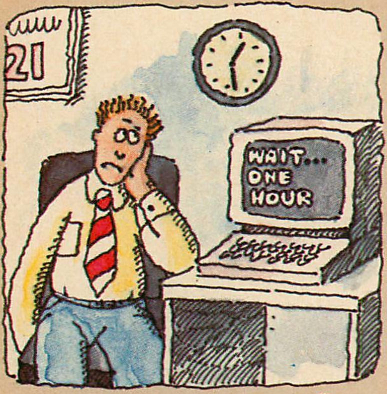
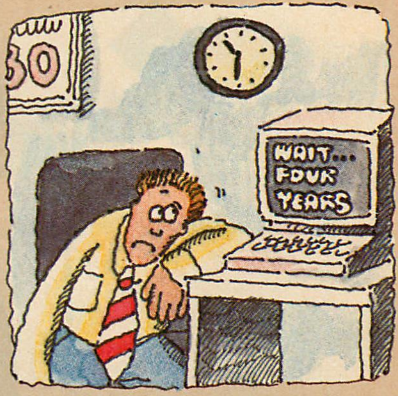


SORT YOUR BILLS

SEARCH YOUR PAYROLL



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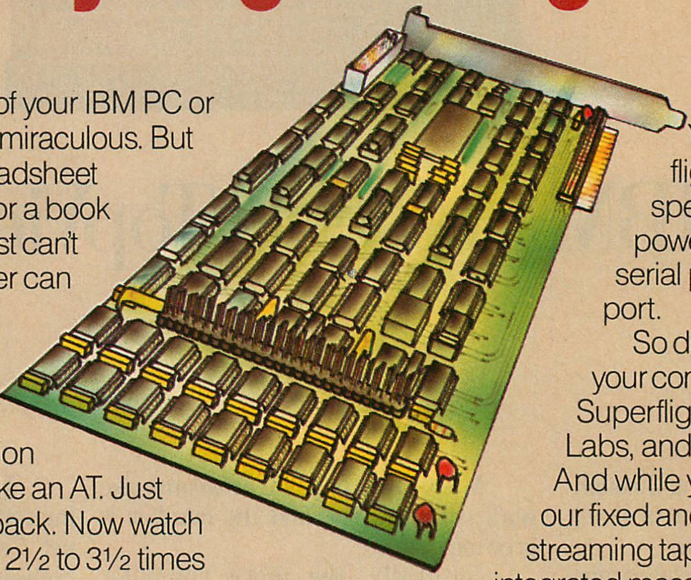

At first, the processing speed of your IBM PC or PC/XT seemed nothing short of miraculous. But lately, asking it to do a large spreadsheet seems like asking a first-grader for a book report on War and Peace. You just can't afford to wait that long. But neither can you afford to buy a new PC/AT.

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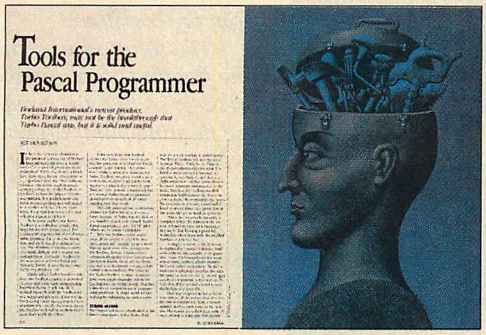
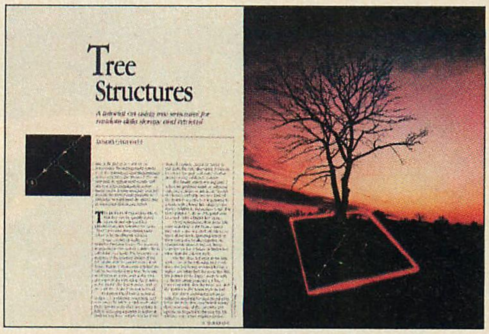




LIBRARY ISSUE

Kudos to your wonderful, practical magazine. I am a programming neophyte, and, although I do not use an IBM or compatible machine, I have found your publication more immediately useful than any other of the many computer periodicals to which I subscribe.

Your February issue simultaneously identified a serious failing of the Turbo Pascal family and corrected it. I too have been frustrated by the sketchy and ambiguous documentation provided with Turbo Toolbox. Atindra Chaturvedi's article on "Tree Structures" (p. 78) and Jeff Duntemann's article on Turbo Toolbox ("Tools for the Pascal Programmer," p.102) have saved me untold weeks of research, study, and frustration. After two days with those articles I am now writing the application for which I purchased Turbo Toolbox, instead of fruitlessly combing the local libraries in search of help.

The February issue of *PC Tech Journal* serves a real need. It is a bona fide manual supplement to Turbo Pascal; it belongs in the library of anyone who has Turbo Pascal.

David Julian Gray
Berkeley, CA

C/PC-DOS CONFLICT

Don Awalt's article on Concurrent PC-DOS from Digital Research Inc. (March 1985, p.45) was a very good, in-depth discussion of that product.

I would differ with him in one important respect. At the end of the article he states three major weaknesses of C/PC-DOS, one of which is that "no throughput advantage is realized by the multiuser or multitasking capabilities."

This is simply not true. Multitasking, multiuser systems from mainframes on down have always been justified on the basis of allowing multiple tasks to take advantage of resources that are not being utilized at a given point in time by other tasks running on the system.

In the C/PC-DOS environment, for example, a FORTRAN compiler can be executing simultaneously with a word processor; the compiler takes advantage of available CPU cycles and disk I/O time that are used very little by the word processor, which is itself almost entirely using screen I/O and keyboard I/O time. There are great amounts of available system resources between each keystroke and also during "think-time" by the user. However, these resources remain entirely unused in a single-tasking environment.

It clearly takes less total time to run a compiler and type a letter concurrently than to run them consecutively, and the throughput, in general, depends on the mix of tasks running.

Stanley Barnett
San Francisco, CA

The dBASE II benchmark provides damning evidence of C/PC-DOS' poor performance, but all our tests produced the same result: it is faster to run tasks one after the other in PC-DOS than it is to run them concurrently in the DRI product. The dBASE II test ran in 33 seconds in DOS. The very same program, running as two identical tasks in C/PC-DOS, took an unbelievable 116 seconds! In DOS, almost four runs could have been made in that time.

This speaks to enormous overhead, more than our collective realtime experience can justify. That same overhead will be present no matter what kind of tasks are running. This observation is also confirmed by our preliminary examination of TopView and Microsoft Windows, both of which are add-on products to DOS and both of which seem to perform better.

—WF

DISKSPACE MISTAKE

Thank you for the splendid articles on Turbo Pascal version 2.0 in the February issue. Keep up the good work.

I would like to point out what appear to be two flaws in one of the routines supplied by Michael Covington ("The Power of Turbo Pascal," p. 112). Specifically, the function diskspace, employing DOS function call hex 36, expects the DX register to return the number of free clusters on the disk in question. However, the DOS manual stipulates that after function call 36, the BX register contains the number of free clusters and that DX contains the total number of clusters on the disk. Free disk space, therefore, should be the product of the BX, AX, and CX registers, not the DX, AX, and CX as indicated.

Furthermore, after making the above change, the function still would not provide accurate information on free disk space with my system (IBM PC, DOS 2.0, and Turbo Pascal 2.0 without 8087 support), often indicating a negative number of free bytes. This problem was apparently related to Turbo Pascal's handling of real numbers. The numbers returned in the AX, BX, and CX registers are not formatted with decimal points. Asking Turbo Pascal to multiply these numbers and produce a result of type real created the aforementioned problem of negative free space. My solution was simply to divide the value of each register by 1.0 before multiplying. This technique produced the desired result.

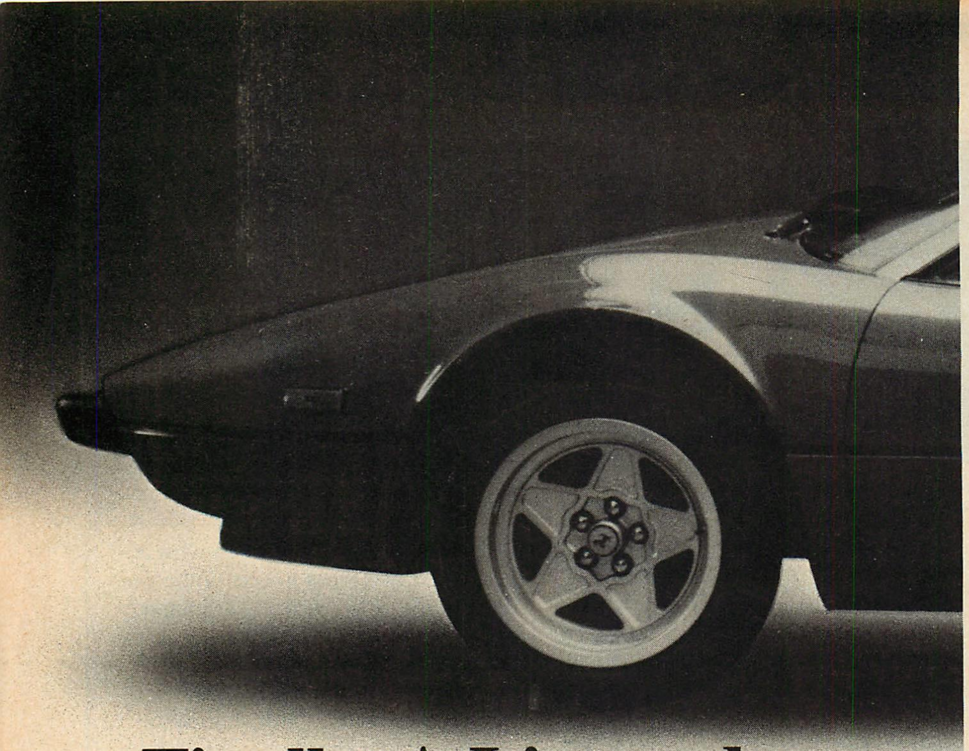
Roy Bechtel
Long Beach, CA

Mr. Bechtel correctly points out that the diskspace routine should get its result from the BX rather than the DX register. (As published, it tells you the total capacity of the disk rather than the amount of free space.)

He also notes that simply saying

```
diskspace := reg.bx*reg.ax*reg.cx
```

won't work, since the product of the three register values is too large to be represented as a Turbo Pascal integer,



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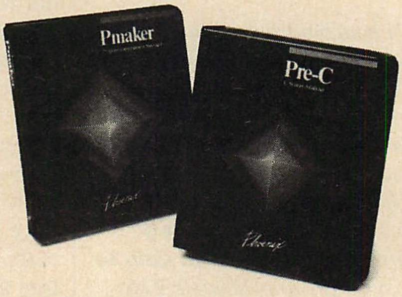

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and spurious negative numbers result from the overflow.

The solution is to include at least one floating-point number in the expression so that the computation will use floating-point arithmetic. The following will all work correctly:

```
diskspace := (256.0*hi
   (reg.bx)+lo(reg.bx))*reg.ax*reg.cx;
diskspace := (reg.bx/1.0)*
   (reg.ax/1.0)*(reg.cx/1.0);
diskspace := 1.0*reg.bx*reg.ax*reg.cx;
```

—Michael Covington

MISLEADING FIGURES

I recently came across two articles of interest to me in past issues of *PC Tech Journal*. The articles, "Significant Figures, I" (Robert Gray, October 1984, p. 54) and "Significant Figures, II" (Robert Gray, November 1984, p. 173), were of interest because significant figures is one of the topics we teach in first-year chemistry at Union College.

Professor Gray shows an excellent understanding of the IBM PC for the performance of arithmetic operations, but the examples that are used to illustrate significant figures in addition and multiplication contain errors. Some of the digits in the examples' sum and product are nonsignificant.

By convention, engineering and scientific data taken by reading a scale on a measuring device are limited to all the certain digits that can be read directly from the scale plus the first estimated digit. These certain digits plus the first uncertain (estimated) digit are defined as significant figures.

As an example, assume a volume of liquid is to be measured out in a glass cylinder that is graduated in milliliters and tenths of milliliters. The space between the tenths markings is too small to contain ten further subdivisions into hundredths of milliliters, so hundredths must be estimated. So, if the liquid meniscus falls about two-thirds of the way between 6.4 and 6.5 milliliters, the volume is properly recorded as 6.47 milliliters. This number has three significant figures with the 7 in the hundredths place uncertain and all digits to its right being unknown. If no other information is given, the uncertain digit is taken to be uncertain by plus or minus one unit. The number 6.47 means that the reader is estimating that the liquid level is between 6.46 and 6.48 milliliters with 6.47 taken as the best estimate.

When another number is added to or subtracted from the 6.47, the sum or difference may have no significant fig-

ure to the right of the 7 in the hundredths position. In manipulating engineering or scientific data, the rule still holds that only the certain digits and the first uncertain digit are retained in any calculated results. This has the unfortunate effect of restricting the number of digits that may legitimately be retained in sums, differences, products, and quotients. If that were not true, we could make extremely crude equipment that could be read to only one figure, and we could then generate all the significant digits we wanted by operating arithmetically on that one digit.

The outcome of these rules may be illustrated by an example similar to the ones in the October issue. We have two numbers, 6.47 and .00098, which are to be added. Presumably, the second number was obtained from a piece of equipment that allowed reading to the fourth decimal place and estimating to the fifth decimal place. The correct addition should look like this:

$$\begin{array}{r} 6.47 \\ \underline{+0.00098} \\ 6.47 \end{array}$$

Reading from left to right in the sum, the 7 in the hundredths position is the first uncertain digit encountered. No digits to its right are significant in the sum by convention. The reason for this result can be seen by rewriting the addition problem:

$$\begin{array}{l} 6.47XYZ \\ \underline{+0.00098} \\ 6.47098 \end{array}$$

Here, X, Y, and Z represent unknown digits. Each may have a value from 0 to 9. If we claim the sum is 6.47098, we are arbitrarily assigning values of 0 to each of the unknown digits. There is no legitimate reason for doing that, and, in fact, by arbitrarily choosing the value of 0 for each case, we have nine chances out of ten of being wrong. Conversely, we have one chance in ten of being right for each digit, or one chance in 1,000 of being right for all three.

There is also a rule for restricting the number of significant figures in a product or quotient. The rule states that there may be no more significant figures in a product or quotient than there are in the number with the fewest significant figures in the multiplication or the division. There may be fewer than that, but there may not be more. In the multiplication 24 * 37, the correct multiplication should look like:

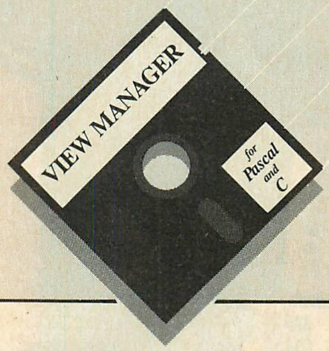
$$24 * 37 = 920 \text{ or } 9.20 * 10^2$$

Because both 24 and 37 have only two significant figures, the product may have no more than two significant figures. The number 918, showing three significant figures, is not correct.

Life would be much easier if calculators and computers knew about significant figures. In the meantime, in IBM advanced BASIC, the commands CINT and PRINT USING "##.##" are worth their weight in gold.

Charles J. Guare
Scotia, NY

Mr. Guare makes an excellent point and one that experienced programmers are familiar with under the more general acronym GIGO—garbage in, garbage out. A computer's output cannot be more accurate than its input. The sum of two numbers cannot be more accurate than the less accurate of the two. Still, the job of an addition routine is just to add—it is not to interpret the data, and my purpose in this article was only to explain addition and floating-point numbers.



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Mr. Guare's misunderstanding probably stems from the title, which is misleading. My original title, "Floating Point Arithmetic: Addition and Subtraction," though mundane, may have been more accurate.

"Significant Figures" has two senses. To an addition routine, all digits are significant. The routine itself has no means of determining whether trailing zeros, for example, are just filler or indications of a measurement's accuracy. But to the person who collects and interprets the data, those figures may be just meaningless filler, and that is why, as Mr. Guare reminds us, all complete floating point libraries include truncation and rounding routines.

—Robert Gray

AIRING OUT

I would like to take a couple of minutes to air a few irritations through your letters column. These irritations have accumulated over the years.

Microcomputers, including the IBM PC and compatibles, are coming to be an impotant tool in scientific research. It is gratifying to see that some support for research use is finally appearing in the microcomputer industry in the form of instrument interfaces, integrated software packages, and even word processors. There is still a lack, however, in the area of mathematical libraries for popular programming languages. Many researchers write their own software and would be very pleased to have such libraries available. Some of the commonly needed functions are curve fitting, matrix manipulation, Fourier and other transforms, digital filtering, and pattern recognition.

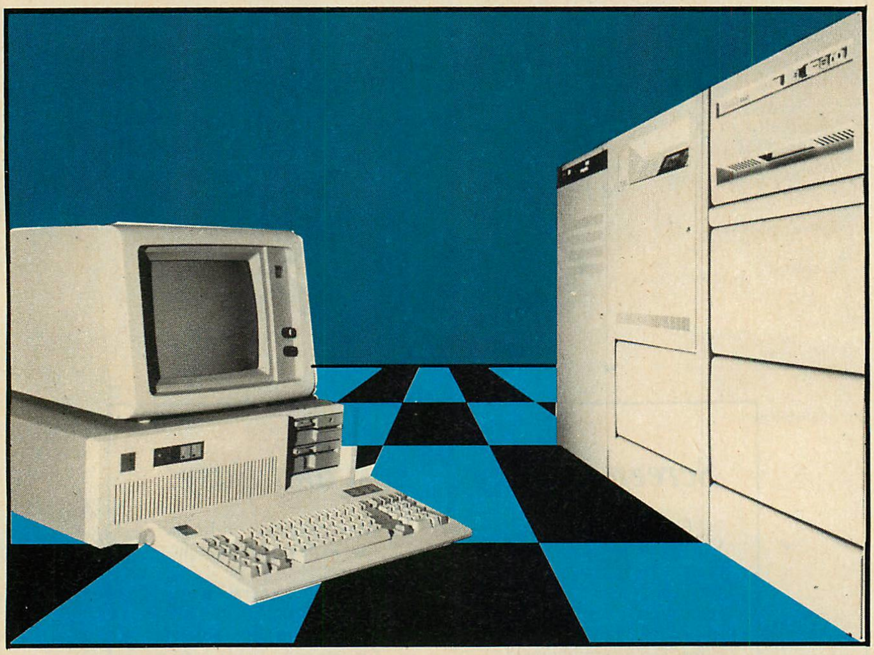
A recent trend that I have observed, and participated in, is the use of the C programming language for large-scale scientific computations. C has many advantages for this type of work, and I have found it to be very satisfactory. Software houses should realize that C is not only a systems language. Reliable and reasonably complete math libraries are a must and should not be provided as an afterthought. As an example, I would like to mention an adventure I have had in using the 8087 math library of Computer Innovations' C86 language. The symptom was irreproducible results from the square root function. After a week and a half, this was found to be due to incomplete input from range checking in the exponential (exp) function, used in a completely different part of the program. Even when the library routines do detect an error, a default result is given and *no error message is presented to the user*. I have met this situation in other C compilers also. This sort of half-hearted software design can cause endless trouble since the results are very hard to diagnose.

I have a few comments regarding the very useful advertising in your magazine. Please put page numbers on advertisement pages. At present it can be very hard to find articles and ads. Also, you and your advertisers should realize that you have foreign readers, such as myself. Response cards should reflect this. Also, non-800 phone numbers should be given in ads so that calls can be made from outside the United States.

Donald Burgess
Hamilton, Ontario

COOLED HIS JET

Your review of the JRAM products ("Enhancement by JRAM-2," Don Awalt, March 1985, p.92) was much appre-



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ciated. What a strange mixture of innovative excellence and plain shoddiness. I have been looking at the JET program and its many nice features, but two things have kept me from purchasing it. One was mentioned in the review: it requires path information with file names, a nuisance to have to remember.

The other, which was not mentioned in the article, is the strange behavior vis-a-vis the archive bit. When JET archives a file with the /K option to reset the archive bit, it resets the archive bit on the target drive vice the source drive. I can't for the life of me figure out what useful purpose this serves. It certainly does not tell any program looking at the source drive whether a file has been archived or not. This is the main feature that has kept JET from being a useful program.

Bob Stephan
Monterey, CA

Mr. Stephan is correct in his description of the /K option. JET enhances the use of electronic disk drives, offering features that COPY and DISKCOPY do not. However, JET is a poor replacement for BACKUP. JET does not back up subdirectory files, and /K does not reset the archive bit of source files. One minor benefit /K offers is the ability to archive updated files from a RAM disk to diskette without preventing subsequent back-up to a fixed disk.

—Don Awalt

PLENTY OF PORTS

I have just read the article in the March 1985 issue of *PC Tech Journal* concerning additional serial ports on a PC ("More Ports," Tech Notebook 32, Jack Wright, p.32). I applaud the author for solving what has been a major stumbling block for us. We at Safeway Stores are putting PC/ATs in our stores and have a requirement for four serial ports to support the applications we are installing. The concept he discusses will enable us to do this.

I have one question, however. I have looked at the AST Advantage board for serial expansion and I have been told by AST that the communications ports available on the card are COM1 and COM2. There is no jumper or switching capability to set the address to 2E8 or 3E8. I understand the requirement to enable to IRQs, but do not understand how to set the additional address. Is there a board you have used and would be able to recommend?

I currently have ATs with two serial/parallel ports. If I understand the information in Mr. Wright's article, I can put an additional serial card in and, via switches and/or jumpers, set its address to x'2E8 and x'3E8 to allow switching between COM1 and COM3 and COM2 and COM4.

Donald Weir
Safeway Stores, Inc.
Oakland, CA

The board I used was the Quadboard II from Quadram, which allows you to configure the addresses of both serial ports easily. I don't know how well the memory portion of that board would work on the AT, though, since the AT requires faster access memory circuitry than the PC. Star Gate Technologies has a board called OCTACOM that allows adding four, six, or eight serial ports to the PC or PC/AT (see "Tech Releases," PC Tech Journal, *April 1985, p. 28). I have not tried it, but it looks like it might do what you need.*

—Jack Wright

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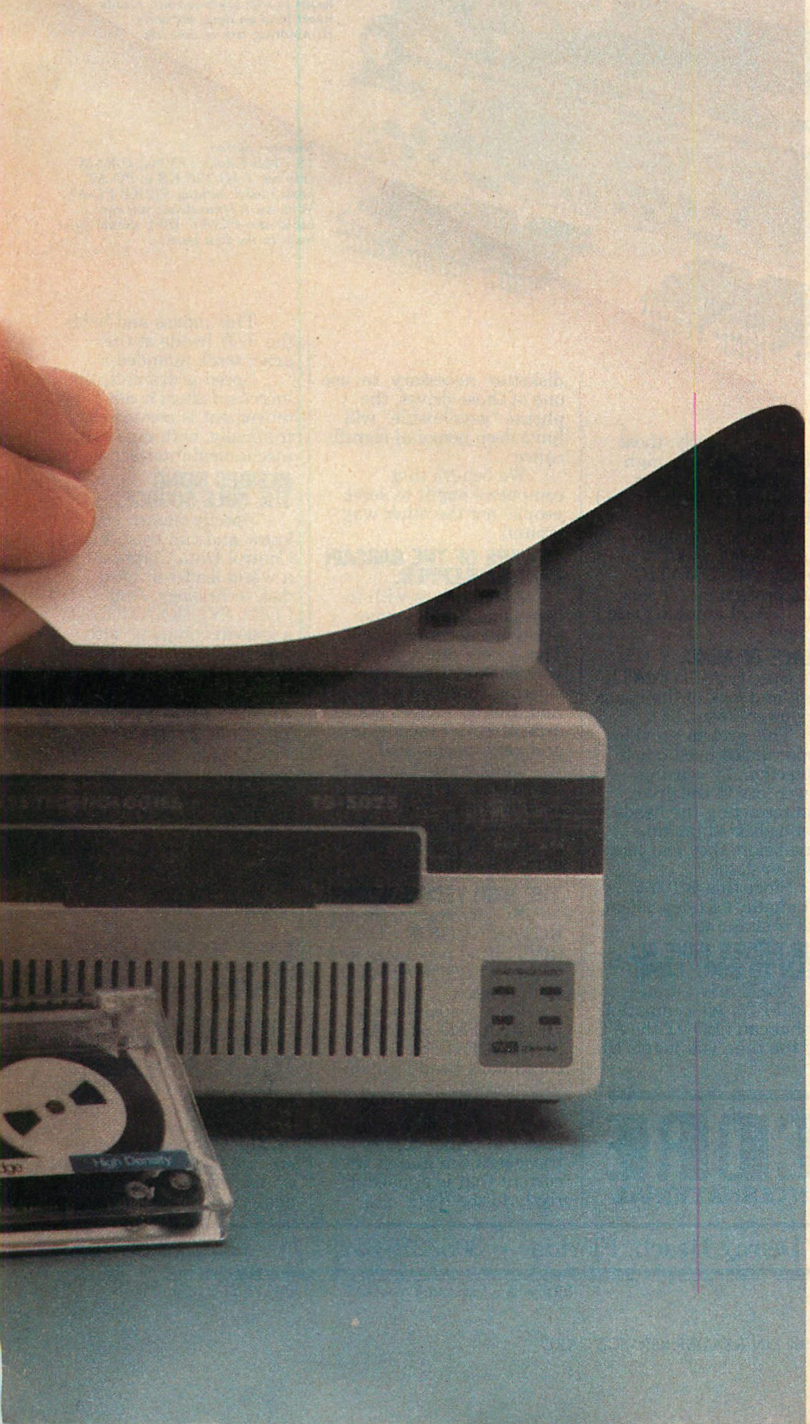

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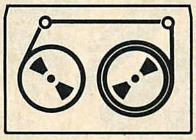
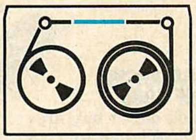
Here's the big news: just like any DOS-controlled hard or floppy disk, PC/T enables you to create directories and files on tape. Then you can call up the exact file you need, and change a portion of the tape without having to erase and overwrite the entire cartridge.



Without PC/T, you have to rewrite the entire 60 MB cartridge each time you make a single change.



With PC/T, you create and directly access files on tape, just like with floppy or hard disk.

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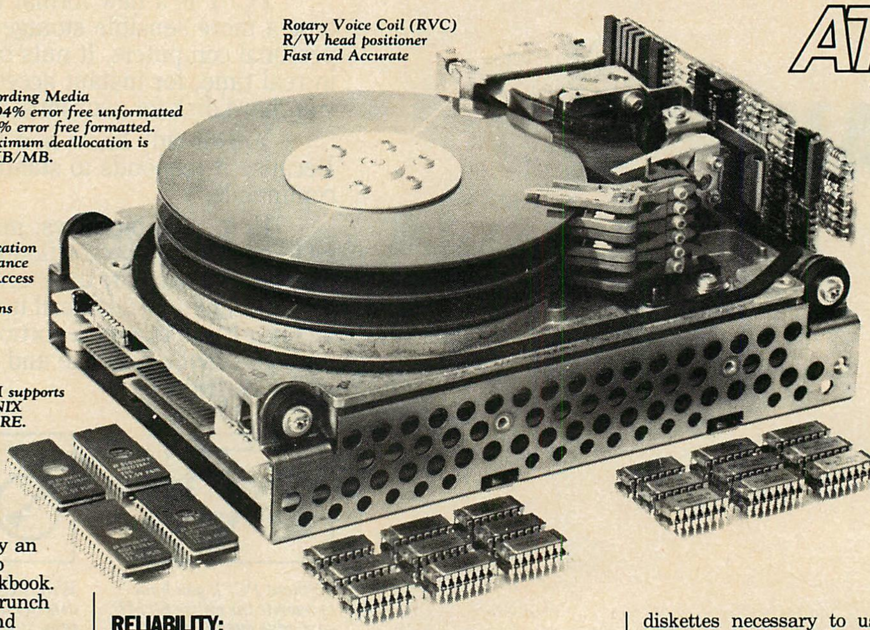

THE BALANCING ACT OF 1985.

You didn't buy an IBM PC-AT just to balance your checkbook. You bought it to crunch lots of numbers and words, in the shortest possible time. A labor saver. A time saver. Hence, a money saver.

So, do your part for effective money management; hard disk storage is no place to be penny-wise and pound foolish.

TELL 'EM YOU NEED HIGH SPEED AND DATA PROTECTION.

These and other important features do add cost, but that makes a premium drive.

Anything that can be made, can be made cheaper, sell for less, offer lower performance, and probably die young.

Remember, usually you get what you pay for, and you ALWAYS get what you don't.

ALL HARD DISKS ARE NOT CREATED EQUAL.

There are vast differences in the speed and reliability of Winchester hard disks. Since the IBM PC-AT is an incredibly fast machine, a slow drive can make an AT run like an XT.

So, before you get stuck with a slow drive in your AT, save your boss two grand and buy an XT.

Or better yet, buy the AT and avoid any drive with Access Times over 40 milliseconds.

RELIABILITY: WHERE HAS ALL THE DATA GONE?

Now tell 'em the drive must have a data protection scheme. One that's easy to use and reliable.

Winchester heads read and write while "flying" a few microns above the data surface. If the heads contact the recording media, you risk a head crash, and significant or total data loss.

So, even a fast drive without data protection is virtually worthless. Frankly, we'd rather sleep at night.

BEWARE OF USER-DEPENDENT PROTECTION SCHEMES.

Some drives have a safe landing zone for the heads, but you need to call a separate program to send 'em there. If you don't call that program, and most folks won't, the heads in these drives ALWAYS land on data when powered down.

The slightest bump or vibration can move the heads, wiping out those data tracks. And the R/W heads can become contaminated, thus increasing the error rate, slowing down average access until the whole drive fails.

Consequently, those drives offer a very high risk of head crashes, a false sense of security, and little else.

What's your data worth? $200? $400? Specify AUTOMATIC data protection. ATplus has it. And it doesn't cost, it pays.

PEACE OF MIND.

Specify AUTOMATIC park and lock of the heads on power down.

This system provides unparalleled head crash protection, by sensing power loss to the drive, and retracting the heads to a dedicated landing zone before they can land on your data.

Since this is 100% automatic, user-dependent risk is eliminated.

OUR DRIVES HAVE ALL BEEN TO BOOT CAMP.

Avoid drives that CLAIM PC-AT compatibility but can't BOOT the AT. By the time you juggle the diskettes necessary to use one of those drives, the phrase "user-hostile" will have deep personal significance.

We believe that computers ought to serve people, not the other way around.

BEWARE OF THE BARGAIN BAND-SCHLEPPER.

Avoid drives with inexpensive Band-Stepper positioner technology. These were pretty good way back in 1980, considering that's all anyone had. But by today's standards, they're inaccurate and very mechanical.

They waste time looking for the right track to read or write. And they're worth no where near the price you'll pay for 'em –in more ways than one.

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This moves and holds the R/W heads at the exact track intended.

Speed is dramatically increased since head movement is created electronically, with minimal mechanical interfacing.

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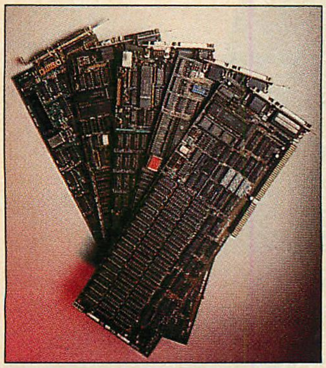

And the Winners Are

It's hard to say which is the best among these five excellent multifunction products for the PC/AT.

PHOTOGRAPH • DAVID ARKY

It has been said that IBM makes only conservative machines. A case in point is the PC/AT. The basic model includes a battery-powered, realtime clock, but it lacks any kind of serial/parallel I/O. (The Enhanced AT does include a serial/parallel board.) Even stranger than that is the fact that the AT's design does not accept 256KB RAM chips; therefore, its four rows of memory sockets can at best contain 512KB of those peculiar piggyback 128KB modules. This limitation is quite odd in a machine that has the power to address as much as 15MB of RAM beyond the PC's "full gallon" of 640KB.

This gap, like other gaps of its kind, was filled rapidly by third-party vendors. The AT's shortcomings provided an in absentia specification for the essential AT multifunction board. All at once, it seems, they have arrived. In scanning a field of five AT multifunction products in an effort to select one as the June Product of the Month, we found a high level of maturity in both technology and product positioning manifested in five products that are very much alike—and uniformly excellent. So rather than single out one of these boards on minor points—as minor as a game port or whether or not a manual was typeset—*PC Tech Journal* elects all five as June's Product(s) of the Month.

The five are, in alphabetical order: AST's Advantage!, Apparat's AT Combo Card, ALR's Challenger, Tecmar's Maestro AT, and STB's Rio Grande. All five provide an essential service in identical fashion: filling out the 256KB or 512KB of RAM on the AT motherboard to the full 640KB. Any on-board RAM beyond what is required to do that is automatically allocated to the AT's extended memory above 1MB.

The amount of RAM that can be added varies from one card to the next. The Challenger can carry as much as 4MB on a piggyback board. The Rio Grande, which lacks a piggyback board, is limited to 1.5MB; but it is a less crowded board with broader traces, giving it a definite edge in reliability and power consumption.

At least one parallel port and one serial port are carried as standard equipment by each of the five boards. In addition, all but the Maestro AT and the AT Combo Card provide an optional serial port, with the Challenger offering as many as three on yet another piggyback board. The Challenger, Advantage!, and Rio Grande boards also offer an optional game port.

Most of the boards sweeten the pot further with bundled software: The Challenger provides a print spooler. The Advantage! includes a sophisticated diagnostic program. The Maestro AT includes Tecmar's popular Treasure Chest anthology of programs, including a checkbook manager, calculator, RAM disk, and print spooler. Oddly, the print spooler can access the AT's extended memory, but the RAM disk cannot.

All five boards evidence very high production standards. The only configuration that gives rise to (minimal) doubts is a fully stuffed Challenger with two piggyback boards—heat buildup is always a problem with so much electronics in so little volume. The documentation for the Advantage! is among the best we have seen for any add-on board, although to be fair, most of the boards came with preliminary versions of their manuals. By the time this issue is published, we would expect production-quality documentation to be shipped with all five boards.

Choosing a standout among this crowd was impossible. The reader, however, can make a decision based on individual needs: a game port, extra serial ports, massive blocks of RAM. If you intend to run UNIX or some other multiuser environment, such as Multilink, the Challenger, with up to four serial ports, could solve any terminal-access problems. If room or power is in short supply and you do not need a lot of extended memory, the Rio Grande might be your first choice. Deciding which board is best will have to be done by creating a matrix of your requirements versus the list of features offered by each product.

Quality, at least, will not be an issue: all five of these multifunction boards are highly recommended.

Advantage!: $595
AST Research, Inc.
2121 Alton Avenue
Irvine CA 92714
714/863-1333

AT Combo Card: $449
Apparat, Inc.
4401 S. Tamarac Parkway
Denver CO 80237
303/741-1778

Challenger: $485
Advanced Logic Research, Inc.
15455 Red Hill Avenue, Suite B
Tustin CA 92680
714/832-7808

Maestro AT: $589
Tecmar, Inc.
6225 Cochran Road
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Prices are for a base configuration with 128KB of RAM, one serial port, and one parallel port.

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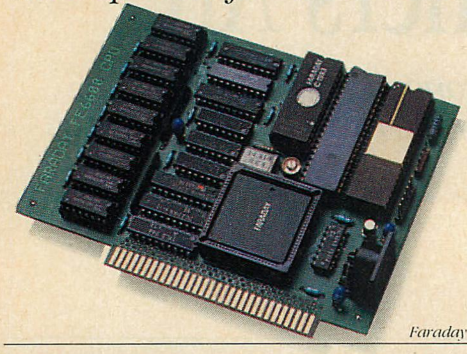


Faraday Electronic's Micro PC

QVT 101 by Qume

HARDWARE

IBM Corporation has introduced two new desktop versions of its Series/1 computer. The IBM **Series/1 5170 model 495** processor consists of a PC/AT and two Series/1 cards—an attachment card with ports for peripheral devices and a processor card with Series/1 memory and logic functions. The IBM **Series/1 4950** comprises two cards and a modified PC/XT. The central processing unit of each model is a highly integrated logic chip developed by IBM's System Products Division. Both models, available only as factory-shipped units, use the PC keyboard and monochrome display as the system console. As many as four IBM 3101 display stations or their equivalents can be locally attached.

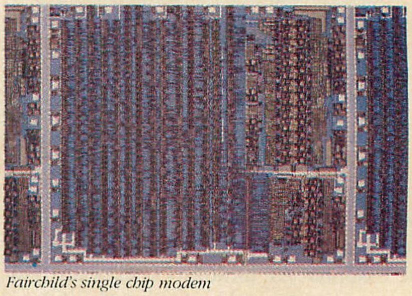
Businesspersons can run existing Series/1 applications programs on the new low-end models, as well as attach multiple display terminals and up to two printers. When they are not running as Series/1s, the computers can be restarted and operated as PCs. IBM also announced that networks of PCs now can use larger Series/1 processors as gateways to communicate with other PC networks or with IBM mainframes.

A new matrix printer was also introduced for the new processors. The **4971 printer,** a bidirectional table-top unit, has a maximum speed of 120 characters per second (cps), with emphasized printing at 60 cps. It has three character sizes: pica, elite, and condensed, and it can print on single-sheet or fanfold paper. Prices: 5170 model 495, $9,420; 4950 model A (10MB fixed disk and 320KB diskette drive), $8,130; 4950 model B (320KB drive), $10,420; 4971 printer, $700. Available in the second quarter of 1985.
IBM Corporation, Information Systems Group, 900 King Street, Rye Brook, NY 10573; 914/934-4488
CIRCLE 309 ON READER SERVICE CARD

Intel Corporation has announced that it has set up an operation to develop IBM PC add-on products for sale to corporate end users. The new organization, called the **Personal Computer Enhancement Operation** (PCEO), has established relationships with nine retail chains and a nationwide network of manufacturers representatives. PCEO began shipping its first products in December, 1984—including Intel's 8087 and 80287 Math Coprocessors. The organization expects to have more than 1,500 dealers and VARs (value-added resellers) by the end of this year, for whom local technical, sales, and training support will be provided by manufacturers' representatives. Intel 8087-3, $200; Intel 80287, $375.
Intel Corporation, Personal Computer Enhancement Operation, 5200 N.E. Elam Young Parkway, Mail Stop TOC, Hillsboro, OR 97124-6497; 503/629-7369
CIRCLE 325 ON READER SERVICE CARD

The first single-chip modem designed to meet the Bell 212A industry standard for 1200-bit-per-second, full-duplex transmission has been announced by **Fairchild Camera and Instrument Corporation's Analog Unit.** The new **uA212A Modem** performs all signal processing functions required for a Bell 212A/103-compatible modem. It incorporates an on-chip switched-capacitor modulator, a digital coherent demodulator, switched-capacitor filters, a 3.6864-mHz crystal oscillator, call-progress detection, and certain control and self-test functions.

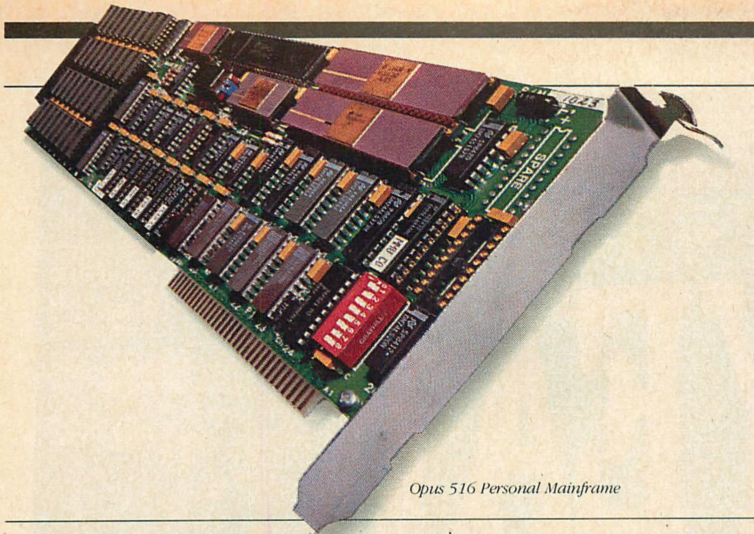
To form a complete cost-effective system, the uA212A requires only a general-purpose, single-chip microcomputer to handle dialing, handshaking protocols, and mode-control functions, and minimal external circuitry to handle the RS-232 interface, ring detection, telephone-line interface, and power supplies. It accommodates high- and low-speed data rates. Fairchild expects the uA212A to be designed into stand-alone modems. The projected price is $82.67 in 100-piece quantities (available in the second quarter of 1985).
Fairchild Camera and Instrument Corporation, Analog Unit, 464 Ellis Street, Drawer No. 7281, Mountain View, CA 94039; 415/962-4042
CIRCLE 310 ON READER SERVICE CARD



Fairchild's single chip modem

Faraday Electronics has announced its **Micro PC** single-board computer. Measuring 3.9 inches by 5.5 inches, it is one-fifth the size of a standard IBM motherboard. It is 100-percent compatible with the IBM PC and was designed to fit into a variety of systems requiring compact size or portability. The Micro PC is designed around Faraday's FE 2010 CMOS integrated circuit. It has an 8088 CPU with optional 8087 coprocessor, 256KB or parity-checked RAM, 32KB of user EPROM space, four DMA channels, three timer channels, one IBM-compatible keyboard port, one speaker port, and one reset port. $695.
Faraday Electronics, 743 Pastoria Avenue, Sunnyvale, CA 94086; 408/749-1900
CIRCLE 315 ON READER SERVICE CARD

The **Model 2300 Interactive Pattern Generator** from **Northwest Instrument Systems** provides a complete prototype debugging capability for engineers. When integrated with the Micro-Analyst 2000 Logic Analysis Workstation (LAW), the Interactive Pattern Genera-



Opus 516 Personal Mainframe

Racore ATcessory

tor's configurable card set creates a complete system for simulation, verification, and analysis.

In the Model 2300, pattern generation provides controlled input to stimulate the system under test while logic analysis monitors the sequence of logic events at key points in the system. Operating under intelligent workstation control, these test tools execute complete, repeatable tests that exercise entire systems and define performance limits. Operating software for the Model 2300 can run stand-alone under PC-DOS or concurrently with the state and timing analyzers under the IBM TopView multitasking environment. Model 2300, including clock controller board and one 32-channel stimulation board, $5,900; additional 32-channel boards, $2,550.
Northwest Instrument Systems, 15201 N.W. Greenbrier Parkway, Suite 140, Beaverton, OR 97006; 503/654-5151
CIRCLE 316 ON READER SERVICE CARD

Model 2300 Interactive Pattern Generator

Opus Systems has introduced the **Opus516 Personal Mainframe**, a UNIX coprocessor subsystem designed to convert an IBM PC to a 32-bit UNIX workstation. Opus516 consists of a complete port of AT&T UNIX System V and a 32-bit coprocessor for the IBM PC and plug-compatible computers; it is based on National Semiconductor's 32016 CPU and includes the 32082 memory-management unit and 32081 floating-point unit. On-board memory is expandable to 2MB. Included with UNIX System V and its utilities are C and FORTRAN 77 compilers, an assembler, and a debugger. 1MB configuration, $3,140.
Opus Systems, Suite 120, 960 San Antonio Road, Los Altos, CA 94022; 415/941-7201
CIRCLE 317 ON READER SERVICE CARD

The **QVT-101** from **Qume Corporation** is a low-priced, smart, full-function editing terminal that provides all the features of the Qume QVT-102 and emulates the Hazeltine 1500, the Lear Siegler ADM 3A/5, and the TeleVideo 910. The QVT-101 features block-mode data transmission, which allows the entire screen contents to be transmitted to the host computer at one time. Multiple interface options allow the terminal to operate remotely. The QVT-101 has the same one-year warranty provided for all Qume terminals, which begins at the date of purchase by the user. $395.
Qume Corporation, 2350 Qume Drive, San Jose, CA 95131; 408/942-4000
CIRCLE 318 ON READER SERVICE CARD

Racore Corporation has two products that enable the PC*jr* to communicate with the PC/AT: **Racore ATcessory**, a 1.2MB floppy-disk drive, and the **RACORE-NET** local area network. ATcessory includes a 1.2MB floppy-disk drive, a parallel printer port, a clock calendar, a DMA (direct memory access) drive controller, a PC/PC*jr* mode switch, and a separate power supply. It snaps onto the top of the PC*jr* and provides the PC software compatibility and floppy-disk interchangeability among the PC, PC/XT, PC/AT, and PC*jr*. RACORE-NET allows up to 16 PC*jr*s, PCs, XTs, and ATs to be linked together. A gateway is included so that RACORE-NET can be linked to the forthcoming IBM PC network. ATcessory, $895; RACORE-NET, $200.
Racore Corporation, 10 Victor Square, Scotts Valley, CA 95066; 408/438-7255
CIRCLE 321 ON READER SERVICE CARD

Intel Corporation has announced **OpenNET**, a comprehensive local area network strategy and product line based on industry standards. OpenNET enables dissimilar microcomputers and operating systems to be joined on a single network. Intel also released four new products: the **iSBC 552 COMMengine** and **iSXM 552 Transport Engine** boards connect microcomputer systems to EtherNet LANs. The **iRMX Networking Software** and **XENIX Networking Software** are products that allow concurrent file sharing to be employed by systems using Intel's iRMX operating system or Intel's version of Microsoft Corporation's XENIX operating system. Prices: iSBC 552 COMMengine board, $1,500; iSXM 552 Transport Engine board, $1,800; iRMX Networking Software, $9,500; and XENIX Networking Software, $9,500 (OEM license).

In a related development, **Ungermann-Bass, Inc.** introduced an addition to its **Personal Connection** product line to allow communication with OpenNET. The product utilizes Ungermann-Bass Personal Connection network controllers to run software that was jointly designed by Ungermann-Bass and Intel to support the PC user on OpenNET systems. The product is based on Ungermann-Bass existing board-level network controllers, the Personal Network Interface Controller (Personal NIC), and the Personal Network Interface Unit (Personal NIU). Both plug into an expansion slot on the PC providing the link for attaching the PC to an EtherNet LAN system. Prices: PC NIC, $595; PC NIU, $1,095; $150 for software.
Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051; 408/987-7219
CIRCLE 311 ON READER SERVICE CARD

Ungermann-Bass, Inc., 2560 Mission College Blvd., Santa Clara, CA 95050; 408/496-0111
CIRCLE 312 ON READER SERVICE CARD

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As sophisticated as they are, you'd think monitor companies could solve a simple problem: keeping customers happy.

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So when you're shopping for a monitor, look at the quality Amdek guarantees you, years after you leave the store.

According to our figures, it really adds up.

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Amdek Corp., 2201 Lively Blvd., Elk Grove Village, IL 60007, 312/595-6890, Telex 280803.

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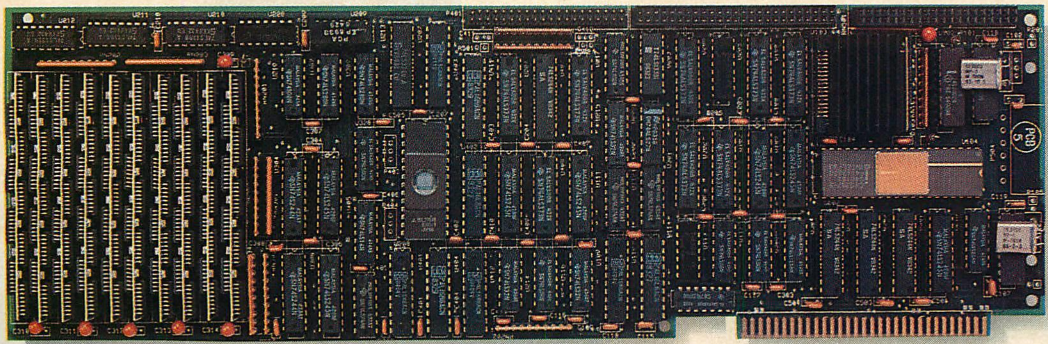
CIRCLE NO. 106 ON READER SERVICE CARD



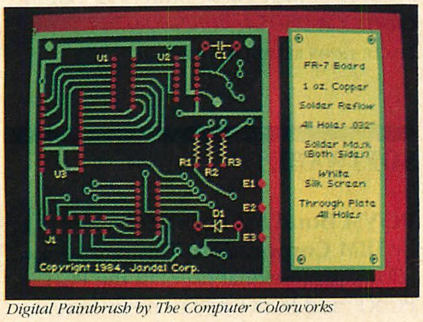
PC-286 by STD

Seattle Telecom & Data, Inc. has announced the availability of the **PC-286** processor board, which plugs into the IBM bus and has an expansion header that replaces the PC's 8088 processor. The board is designed to run 5-, 6-, or 8-mHz iAPX286 processor chips, as well as its companion 80287 math coprocessor. The PC-286 generates all 8088 timing and completely takes over the PC's bus. The iAPX286 processor is run in native mode and runs all PC-DOS software, unmodified. The PC-286 board runs on the PC, PC/XT, and compatibles; all boards have 128KB memory. It is particularly well suited to applications requiring high computational horsepower, such as CAD, CAE, LAN, and UNIX-type applications. Prices: 5-mHz board, $1,995; 6-mHz board, $2,515; 8-mHz board, $2,995.
Seattle Telecom & Data, Inc., 2637 151st Place N.E., Redmond, WA 98052; 206/883-8440
CIRCLE 327 ON READER SERVICE CARD

IRMAvision, a monochrome display adapter that enables IRMA-equipped IBM PCs, PC/XTs, and PC/ATs to emulate IBM 3278 models 2 through 5, has been announced by **Digital Communications Associated, Inc.** IRMAvision is a full-length printed circuit board that fits into any available slot in the PC and works with the IBM Monochrome Display. It is totally compatible with IRMA, DCA's micro to mainframe interface. $695.
Digital Communications Associates, Inc., 303 Technology Park, Norcross, GA 30092; 404/448-1400
CIRCLE 313 ON READER SERVICE CARD

The IBM PC version of **Digital Paintbrush System** has been introduced by **The Computer Colorworks**. Digital Paintbrush is a complete hardware/software color graphics package designed for the scientific professional who must manipulate graphical data; it is designed for use on the PC, PC/XT, PC/AT, and compatibles. Graphic images made with Digital Paintbrush can be shown like slides on a color monitor or television screen, printed as hard copy or as transparencies for overhead projection, and photographed with hood cameras.

The hardware, a unique, high-resolution digitizing device, is the Digital Paintbrush—it consists of a ball-point-pen-like stylus and two rotating potentiometers housed in a plastic case and attached to the pen tip by strong, lightweight control lines. Movement of the pen is detected by the potentiometers and interpreted by the Digital Paintbrush Systems software, enabling fast and accurate reproduction of pen movements onto the computer screen. $450.
The Computer Colorworks, 3030 Bridgeway, Suite 201, Sausalito, CA 94965; 415/331-3022
CIRCLE 324 ON READER SERVICE CARD



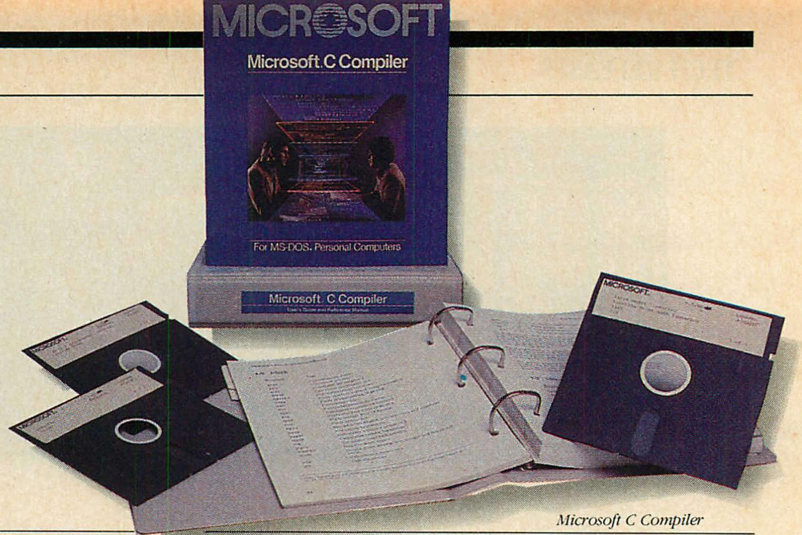
Digital Paintbrush by The Computer Colorworks

TAT Graphics Group now offers the **Sextant Graphics Display System** family of display systems that offers dual-mode resolution capability within the same TAT monitor and single-board, high-resolution color graphics display controllers for the PC. The Sextant series includes the TAT Galaxy G640, G800, and GX1024 controllers combined with either the Sextant 14-inch or 19-inch color monitor. Five Sextant systems are available: two resolutions with 14-inch displays (614 and 814) and three resolutions with 19-inch displays (models 619, 819, and 1019). All TAT Galaxy controllers are based on the NEC 7220 graphics processor. Models 614 and 814, $3,600 each; Models 619 and 819, $4,900 each; Model 1019, $5,400.
TAT Graphics Group, Inc., 1270 Lawrence Station Road, Bldg. E, Sunnyvale, CA 94089; 408/734-2202
CIRCLE 319 ON READER SERVICE CARD

From **PRIAM Corp.** comes a high-speed, 5¼-inch add-in disk drive kit called **InnerSpace** that is designed to enhance the storage capacity of the PC/AT. It is available in two versions: the **ID40-AT**, a 43MB drive, and the **ID60-AT**, a 60MB drive. Both versions access data at about 30 milliseconds. InnerSpace consists of a complete add-in kit with cables, installation software, an instruction manual, and a reference guide. It requires no additional power supply, interface, or controller and fits within the inner shell of the AT. ID40-AT, $2,195; ID60-AT, $2,595.
PRIAM Corp., 20 W. Montague Expressway, San Jose, CA 95134; 408/946-4600
CIRCLE 314 ON READER SERVICE CARD

The **Thiefstopper** from **INMAC** is a sensitive motion detector that attaches to a PC or PC/XT and delivers a 90-decibel alarm to help scare off potential burglars or unauthorized borrowers. The alarm hooks into the PC's (or XT's) ventilation slots and secures with a screw already on the computer. The computer housing fits over the alarm. The system is activated with the push of a switch; if anyone attempts to lift or move the computer, the alarm will sound for up to five days or until turned off with the key. Thiefstopper is powered by a nine-volt alkaline battery. It measures six inches by three inches by three and one-half inches. $99.
INMAC, 2465 Augustine Drive, Santa Clara, CA 95054; 800/547-5444; in California, 800/547-5447
CIRCLE 320 ON READER SERVICE CARD

Toshiba P351 3-in-One printer



Microsoft C Compiler

Toshiba's Information Systems Division has introduced an enhanced version of its popular 24-pin 3-in-One dot-matrix printer. The **P351** has innovative features, such as plug-in font cartridges and a high-speed draft printing rate of as many as 288 characters per second—one of the fastest currently available on the market. Other new features include a redesigned acoustical cabinet that reduces the noise level by four decibels, Qume Sprint 11 letter-quality emulation, a forward-stacking sheetfeeder, and the ability to boldface without any degradation in print speed. Toshiba's new cartridge-loading system complements its line of 41 downloadable fonts available as options on floppy disks. Resident character sets within the P351 include letter-quality Courier, Prestige Elite, condensed, draft-quality, and proportional spacing. With the forward-stacking sheetfeeder, the P351 ejects documents in ready-to-read order. $1,895.
Toshiba America, Inc., Information Systems Division, 2441 Michelle Drive, Tustin, CA 92680; 714/730-5000
CIRCLE 323 ON READER SERVICE CARD

Smart Switch Box, SSB1000, from **IQ Technologies**, connects a modem and two peripherals to a single computer. It has one computer port and three peripheral ports, one dedicated to modems and the other two for printers, plotters, and terminals. Unlike conventional switch boxes that require custom cables between the machine and switch box, Smart Switch Box interconnection cables are low-cost, straight-through 25-wire ribbon cables. SSB1000 utilizes the same logic circuitry as another IQ Technologies product, Smart Cable, to make the correct RS-232 interconnection between virtually all computers and peripherals. $159.95.
IQ Technologies, Inc., 11811 N.E. First Street, Suite 308, Bellevue, WA 98005; 206/451-0232
CIRCLE 322 ON READER SERVICE CARD

Corporate Data Sciences, Inc. has announced a high-resolution laser printer, **Model CDS 2300**, for use in the automated office and corporate electronic publishing environments. The new laser printer provides 90,000 dots per square inch (300 dots by 300 dots). Because CDS 2300 has 1.28MB of RAM to store a bit map of an entire 8½-by-11-inch page, it can print a full page of graphics material and handle different type fonts and sizes. The CDS 2300 connects to most personal computers through a serial or Centronics port. It offers four principal operating modes: Diablo 630, Tektronix 4014 emulation, ANSI X3.64, and full-bit map-image mode. The CDS 2300 controller uses an 8mHz 80186 microprocessor. After loading a page of text and graphics, the system prints at the rate of eight pages per minute. $5,695.
Corporate Data Sciences, Inc., 2560 Mission College Blvd., Suite 102, Santa Clara, CA 95054; 408/980-9747
CIRCLE 326 ON READER SERVICE CARD

SOFTWARE

PC/VM Bond has been announced by **IBM Corporation**. This new tool allows professional users of the PC, PC/XT, and PC/XT 370 to easily access and use the power of VM (virtual machine) systems, providing enhanced support for the DOS environment. PC/VM Bond consists of two programs, **VM Bond** and **PC Bond**, that allow PC users with little or no VM experience to access large disk storage capability and to share data disks between users. It also provides VM and PC message services, a command interpreter (REXX/PC) for the PC, and full-screen 3278/79 terminal emulation. VM Bond, $125; PC Bond, $2,000.
IBM Corporation, 900 King Street, Rye Brook, NY 10573; 914/934-4000
CIRCLE 331 ON READER SERVICE CARD

Microsoft Corporation has announced the release of a new, internally developed **Microsoft C compiler (version 3.0)**, with additional performance features that increase both the execution speed and the compactness of C programs. Programs written with Microsoft's previous version of the C compiler can be recompiled easily with the new Microsoft C compiler using conversion tools provided with the package. The source and object code for programs can be transferred easily from MS-DOS to XENIX and vice versa. $395.
Microsoft Corporation, 10700 Northup Way, Box 97200, Bellevue, WA 98009; 206/828-8080
CIRCLE 328 ON READER SERVICE CARD

IBM PC/AT-compatible ROM BIOS software for the OEM market has been introduced by **Phoenix Software Associates Ltd.** The software will be licensed to manufacturers of IBM-compatible personal computers as part of a package for systems software compatibility. It includes an AT DOS-compatible version of MS-DOS, a range of utilities, the GW BASIC language configured to resemble IBM's BASICA, and ROM software for an AT-compatible 8042 keyboard controller chip interface.

The AT compatibility package was developed using the same strict controls to ensure originality and avoid copyright infringement on IBM that the company employed in developing its PC and PC/XT versions. The AT compatibility systems software package is available to OEMs for unlimited use licensing at a total package price of $440,000. Individual component prices: AT ROM BIOS, $200,000; AT-compatible version of MS-DOS, $60,000; utilities, $60,000; AT-compatible version of GWBASIC, $100,000; 8042 chip support, $20,000.
Phoenix Software Associates Ltd., 1420 Providence Highway, Suite 101, Norwood, MA 02062; 617/769-7020
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MOST SIGNIFICANT PRODUCT OF THE YEAR - PC WEEK

They said it couldn't be done. Borland Did It. Turbo Pascal 3.0

The industry standard

With more than 250,000 users worldwide Turbo Pascal is the industry's de facto standard. Turbo Pascal is praised by more engineers, hobbyists, students and professional programmers than any other development environment in the history of microcomputing. And yet, Turbo Pascal is simple and fun to use!

	TURBO 3.0	TURBO 2.0	MS PASCAL
COMPILATION SPEED	8.1	16	206
EXECUTION SPEED	9 SEC	13 SEC	20 SEC
CODE SIZE	12 K	12 K	35 K
BUILT-IN INTERACTIVE EDITOR	YES	YES	NO
ONE STEP COMPILE (NO LINKING NECESSARY)	YES	YES	NO
COMPILER SIZE	39K	35K	300K+
TURTLE GRAPHICS	YES	NO	NO
BCD OPTION	YES	NO	YES
PRICE	$69.95	$54.95	$295.00

(*) **Benchmark** run on an IBM PC using MS Pascal version 3.2 and the DOS linker version 2.6. The 179 line program used is the "Gauss-Seidel" program out of Alan R. Miller's book: *Pascal programs for scientists and engineers* (Sybex, page 128) with a 3 dimensional non-singular matrix and a relaxation coefficient of 1.0.

The best just got better: Introducing Turbo Pascal 3.0

We just added a whole range of exciting new features to Turbo Pascal:

- First, the world's fastest Pascal compiler just got faster. Turbo Pascal 3.0 (16 bit version) compiles twice as fast as Turbo Pascal 2.0! No kidding.
- Then, we totally rewrote the file I/O system, and we also now support I/O redirection.
- For the IBM PC versions, we've even added "turtle graphics" and full tree directory support.
- For all 16 Bit versions, we now offer two additional options: 8087 math coprocessor support for intensive calculations and Binary Coded Decimals (BCD) for business applications.
- And much much more.

The Critics' Choice.

Jeff Duntemann, PC Magazine: *"Language deal of the century . . . Turbo Pascal: It introduces a new programming environment and runs like magic."*

Dave Garland, Popular Computing: *"Most Pascal compilers barely fit on a disk, but Turbo Pascal packs an editor, compiler, linker, and run-time library into just 39K bytes of random-access memory."*

Jerry Pournelle, BYTE: *"What I think the computer industry is headed for: well documented, standard, plenty of good features, and a reasonable price."*

Portability.

Turbo Pascal is available today for most computers running PC DOS, MS DOS, CP/M 80 or CP/M 86. A XENIX version of Turbo Pascal will soon be announced, and before the end of the year, Turbo Pascal will be running on most 68000 based microcomputers.

An Offer You Can't Refuse.

Until June 1st, 1985, you can get Turbo Pascal 3.0 for only $69.95. Turbo Pascal 3.0, equipped with either the BCD or 8087 options, is available for an additional $39.95 or Turbo Pascal 3.0 with both options for only $124.95. As a matter of fact, if you own a 16-Bit computer and are serious about programming, you might as well get both options right away and save almost $25.

Update policy.

As always, our first commitment is to our customers. You built Borland and we will always honor your support.

So, to make your upgrade to the exciting new version of Turbo Pascal 3.0 easy, we will accept your original Turbo Pascal *disk* (in a bend-proof container) for a trade-in credit of $39.95 and your Turbo87 original *disk* for $59.95. This trade-in credit may only be applied toward the purchase of Turbo Pascal 3.0 and its additional BCD and 8087 options (trade-in offer is only valid directly through Borland and until June 1st. 1985).

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Carefully Describe your Computer System!

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I Use: ___ PC-DOS ___ MS-DOS ___ CP/M 80 ___ CP/M 86

My computers' name/model is: ____

The disk size I use is: ☐ 3½" ☐ 5¼" ☐ 8"

Name: ____

Shipping Address: ____

City: ____ Zip: ____

State: ____

Telephone: ____

For update: original Turbo disk must accompany order

YES! I want the Best! Please send: Quantity

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Pascal w/8087 $109.90 ____

Pascal w/BCD $109.90 ____

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* These prices include shipping to all U.S. cities. All foreign orders add $10 per product ordered.

Subtotal (CA 6% tax) ____

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Amount Enclosed: ____

Payment: VISA MC BankDraft Check

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6

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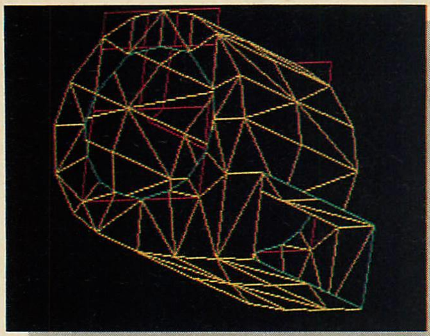


IMAGES-3D by Celestial Software

Syslog by Apex Resource

Apex Resource has announced the release of a new software utility that permits the logging of computer time usage. **Syslog**, the system log utility, provides semiautomatic record keeping that includes log on/off date and time, operator, project, and elapsed time. The utility accumulates total elapsed time on the computer by both business and non-business categories and reports this information by percentage. Reporting options include date range, entry number range, operator, and project.

Syslog is especially useful to PC users who are required to maintain a computer log under the Tax Reform Act of 1984. Syslog also is useful for professionals who charge for computer time, or businesses that keep records of how their computers are used. Syslog works with most DOS 2.0-compatible computers and requires 128KB, display, one disk drive, printer, and MS-DOS 2.0 or later. $29.95.
Apex Resource, 23 Christine Court, Stormville, NY 12582; 914/221-2611
CIRCLE 329 ON READER SERVICE CARD

The **IBM Local Area Network Print-Manager** licensed program provides support for sharing an IBM 3820 Page Printer on the IBM PC Network. Print-Manager also runs with Corvus Systems' OMNINET. PrintManager, together with the IBM 3820, provides LAN users with volume cut-sheet printing from PC-based applications on an all-points-addressable laser printer. PrintManager menus allow users to build personalized formatting and printing profiles, including the following options: 54 fonts; print simplex or use of two duplex modes; four print orientations; the ability to set margins, line spacing, and tabs; and ten paper types. $800.
IBM Corporation, Information Products Division, Dept. 53D, P. O. Box 1900, Boulder, CO 80301-9191; 303/447-7259
CIRCLE 335 ON READER SERVICE CARD

Hammer Computer Systems, Inc. has introduced its first product, the **E-Z-DOS-IT** concurrent processing system-level software package. E-Z-DOS-IT is a single floppy system that enables the user to load as many as eight programs and process them concurrently. Easy to use, it is specifically designed for the PC, PC/XT, and PC compatibles. E-Z-DOS-IT is compatible with all of the most popular applications programs, including Lotus 1-2-3, dBASE II, Wordstar, and PFS:File. The user selects which program communicates to the screen and also prioritizes the processing capacity of the software, beginning and ending jobs as desired. $199.95.
Hammer Computer Systems, Inc., 700 Larkspur Landing Circle, Suite 285, Larkspur, CA 94939; 415/461-7633
CIRCLE 332 ON READER SERVICE CARD

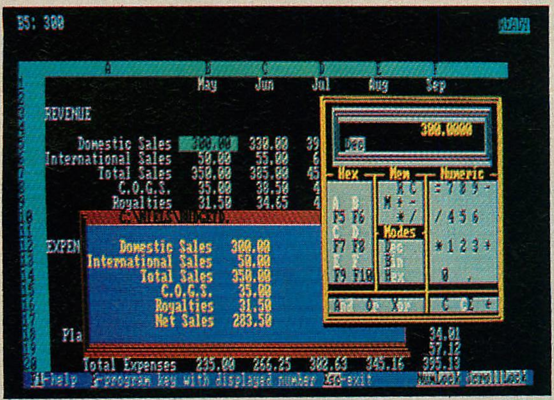
Torus Systems, Inc. has announced LAN software for IBM's PC Network and made public a distribution agreement between Torus Systems Ltd. and IBM. The product, called **Tapestry**, is a software package that enables IBM PCs, connected by IBM's PC Network hardware, to operate as an office automation system. Tapestry integrates all LAN functions (file sharing, electronic mail, and printer sharing) in an easy-to-use, icon-based operating environment. It extends the networking concept by providing modem sharing, gateways to mainframes, telephone management, and an applications library from which PC-DOS applications may be downloaded. Its icon interface covers most operating system commands. Tapestry supports the PC, PC/XT, and PC/AT; it requires a Network Manager Pack for the server and a Workstation Pack for each additional PC on the network. Network Manager Pack, $400; Workstation Pack, $400.
Torus Systems, Inc., 485 Seaport Court, Suite 103, Redwood City, CA 94063; 415/363-2418
CIRCLE 337 ON READER SERVICE CARD

Celestial Software, Inc. has introduced **IMAGES-3D**, a program for three-dimensional static and dynamic finite element analysis. Written in engineering terminology for the PC/XT, PC/AT, and compatibles, with 300 nodes, 1800 degrees of freedom, and six elements, IMAGES-3D is suited for applications ranging from packaging and mechanical design to piping and space frame analysis. Extensive graphics features allow users to generate and view multicolored models from any perspective at any window. Fully animated, multicolored dynamic mode shapes and static deflected mode shapes also can be displayed. Viewing choices include rotation, zoom, hidden line removal, out-of-plane clipping, surface and boundary plotting, and element numbering. IMAGES-3D is menu-driven and interactive; it includes HELP commands plus extensive error trapping and error messages. License fees: $1,500 for static analysis; $3,900 for the static and dynamic package.
Celestial Software, Inc., 125 University Avenue, Berkeley, CA 94710; 415/841-7175
CIRCLE 333 ON READER SERVICE CARD

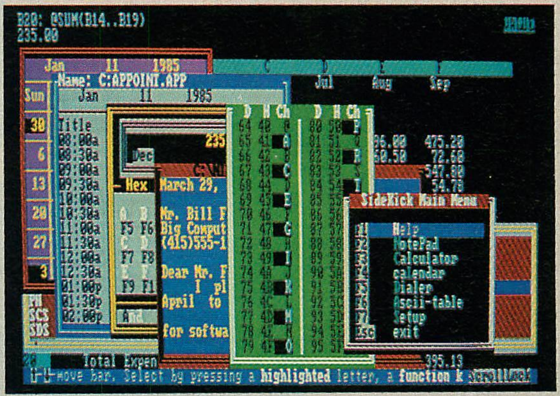
CX/PC, a realtime C language executive for the PC and compatibles, has been released by **INTR-SOFT Company**. CX/PC provides a task-scheduling and message-passing environment for user-written realtime instrumentation and control programs. The executive includes a priority task scheduler and 14 functions to queue intertask messages and pointers. Interrupt-driven interfaces to the PC timer and serial and parallel ports are provided. Five programs demonstrate all features. Copyrighted DeSmet C source files include example tasks and a general-purpose timer utility task. User-written binary programs may be sold without obtaining a license. $75.
INTR-SOFT Company, P. O. Box 351, Bedford, MA 01730; 617/369-6242
CIRCLE 339 ON READER SERVICE CARD

Borland's SideKick Software Product of the Year*

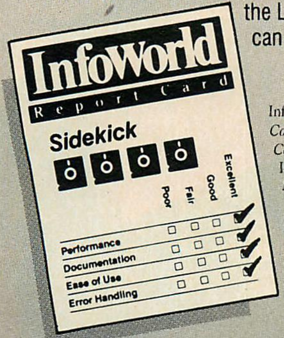
SideKick is InfoWorld Software Product of the Year. It won over Symphony. Over Framework. Over ALL the programs advertised in this magazine. Including, of course, all the "fly-by-night" SideKick imitations. SideKick . . . . Simply the best.



Here's **SideKick** running over Lotus 1-2-3. In the SideKick **Notepad** you'll notice data that's been imported directly from the Lotus screen. In the upper right you can see the **SideKick Calculator**.



All the **SideKick** windows stacked up over Lotus 1-2-3. From bottom to top: SideKick's **"Menu Window"**, **ASCII table**, **Notepad**, **Calculator**, **Appointment Scheduler/Calendar**, and **Phone Dialer**. Whether you're running WordStar, Lotus, dBase, or any other program, SideKick puts all these desktop accessories instantly at your fingertips.



InfoWorld *Report Card* 1984 by *Popular Computing, Inc., a subsidiary of CW Communications Inc. Reprinted from* InfoWorld, *1060 Marsh Road, Menlo Park, CA 94025.*

Jerry Pournelle, BYTE: *"If you use a PC, get SideKick. You'll soon become dependent on it."*

Garry Ray, PC Week: *"SideKick deserves a place in every PC."*

Charles Petzold, PC Magazine: *"In a simple, beautiful implementation of WordStar's block copy commands, SideKick can transport all or any part of the display screen (even an area overlaid by the notepad display) to the notepad."*

Dan Robinson, InfoWorld: *"SideKick is a time-saving, frustration-saving bargain . . . ."*

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Symphony, Lotus & Lotus 1-2-3 are trademarks of Lotus Development Corp. dBase & Framework are trademarks of Ashton-Tate. WordStar is a trademark of Micropro International Corp. SideKick is a trademark of Borland International.

*Selected by *InfoWorld* as the most significant software product of the year.

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SuperKey turns 1,000 keystrokes into 1! Yes, SuperKey can *record* lengthy keystroke sequences and play them back at the touch of a single key. Instantly. Like Magic. Say, for example, you want to add a column of figures in 1-2-3. Without SuperKey you'd have to type seven keystrokes just to get started. ["shift-@-s-u-m-shift-("]. With SuperKey you can turn those 7 keystrokes into 1.

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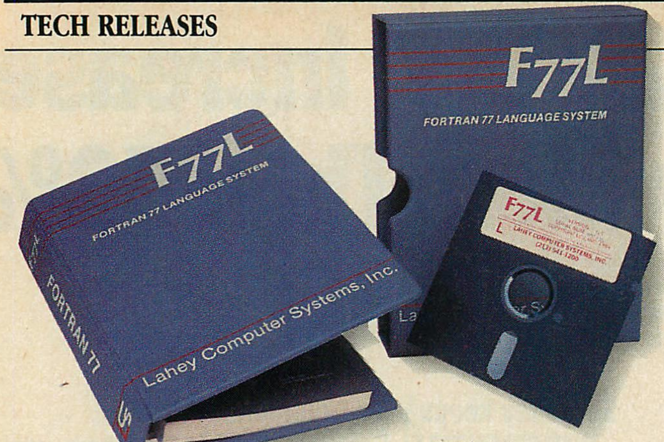

F77L by Lahey

FORMULA/ONE by Alloy

F77L, the complete implementation of the ANSI FORTRAN 77 Standard for the PC and compatibles, has been announced by **Lahey Computer Systems, Inc.** F77L is designed for programmers who want mainframe features implemented on the PC. It adds four types to the six standards: LOGICAL*1, REAL*8, INTEGER*2, and COMPLEX*16; it also includes many IBM H features, such as $ in a name, eight-character names, and initialization in type statements. Other features include optional checking—subscript, subprogram class, argument, and alternate return count; execution error messages that provide text and a subprogram/line-number trace-back; and source files that can be free-format or standard. $477.
Lahey Computer Systems, Inc., 31244 Palos Verdes Drive West. Suite 243, Ranchos Palos Verdes, CA 90274; 213/541-1200
CIRCLE 334 ON READER SERVICE CARD

Network Software Associates, Inc. has announced two new products. **AdaptSNA PCcom** allows IBM PCs to communicate with each other using IBM's SNA/SDLC protocol. It offers high-speed PC-to-PC communications and file transfer without the need for mainframe intervention. Although AdaptSNA PCcom can be used for any such application, it is particularly well suited for large corporate SNA (systems network architecture) switched networks. In such networks, PCs typically are equipped with IBM SDLC adapter cards and synchronous modems for 3270 or RJE (remote job entry) mainframe communications. The PCcom software permits communications between the PCs—communications previously not allowed.

The **AdaptSNA/OEM** is a new micro-to-mainframe communications emulator specifically designed for OEM (original equipment manufacturer) needs. The product emulates an IBM 3270 or RJE terminal in an SNA environment. The emulator is operating system independent, allowing virtually any system to communicate with IBM mainframes; it is written mostly in C. Prices: AdaptSNA PCcom, $475; AdaptSNA/OEM, pricing will be based on an OEM licensing agreement that may vary.
Network Software Associates, Inc., 19491 Sierra Soto, Irvine, CA 92715; 714/768-4013
CIRCLE 340 ON READER SERVICE CARD

Alloy Computer Products, Inc. has introduced **FORMULA/ONE,** a high-powered, problem-solving software package that permits calculation of complex mathematical equations without requiring computer programming experience. Developed for the PC, PC/XT, and compatibles with at least 256KB RAM, FORMULA/ONE is designed specifically for professionals who previously used programmable calculators or customized computer software to solve mathematical problems. Utilizing such significant features as context-sensitive HELP and DOS-like commands, users can set up problems automatically, vary assumptions, solve equations, plot graphs, and compute unknown variables in complex formulas and models. Sophisticated programming techniques let FORMULA/ONE solve these tasks up to five times faster than competing products. $395.
Alloy Computer Products, Inc., 100 Pennsylvania Avenue, Framingham, MA 01701; 617/875-6100
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Nastec Corporation has introduced the **NASTEC CASE** 2000 Environment, which provides broad support for improving the quality and efficiency of systems development. The CASE (computer-aided software engineering) 2000 Environment architecture is divided into three major elements: a development series containing professional tools for systems developers, a management series containing planning and control tools for project management, and an operating environment providing users choices of workstation and information-sharing alternatives. Nastec has announced the availability of its **DesignAid** software for the PC, PC/XT, PC/AT, and the 3270 PC. Part of the development series, DesignAid is a professional toolkit that includes GraphiText, a full-screen editor for documentation and design support, including integrated graphics and text handling. Software for the PC family from the other two major elements of the CASE 2000 Environment is under development. A graphics board is required to run the software. DesignAid, $6,900; graphics board, $695.
Nastec Corporation, 24681 Northwestern Highway, Southfield, MI 48075; 313/353-3300
CIRCLE 343 ON READER SERVICE CARD

GraphiC 2.0, from **Scientific Endeavors**, is a set of C-callable routines that can create presentation-quality scientific graphics. All plots are created with 4,096-by-3,120 pixel resolution in Tektronix format. This format allows the transfer of finished plots to mainframe computers for printing or further processing. (In general, GraphiC follows the routine names of ISSCO's DISSPLA package for mainframes.) It has routines that create linear, log, semilog, three-dimensional, and contour plots. New to version 2.0 is a full set of three-dimensional routines for curves and surfaces, including hidden-line removal and proper labeling of all plots. The contour plot routines were rewritten to allow labels of the individual contours and the use of different line types; the selection of fonts is greatly expanded. Complete user customization is possible because GraphiC is available only with source code; it is written mostly in C. $250; demonstration disk, $8.
Scientific Endeavors, Route 4, Box 79, Kingston, TN 37763; 615/376-4146
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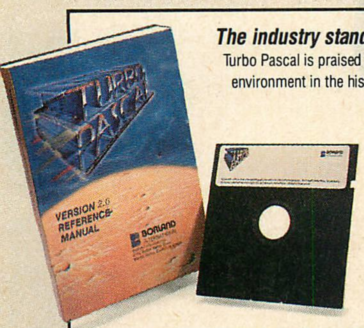

The industry standard. With more than 250,000 users worldwide Turbo Pascal is the industry's de facto standard. Turbo Pascal is praised by more engineers, hobbyists, students and professional programmers than any other development environment in the history of microcomputing. And yet, Turbo Pascal is simple and fun to use!

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Jeff Duntemann, PC Magazine: *"Language deal of the century . . . Turbo Pascal: It introduces a new programming environment and runs like magic."*

Dave Garland, Popular Computing: *"Most Pascal compilers barely fit on a disk, but Turbo Pascal packs an editor, compiler, linker, and run-time library into just 29K bytes of random-access memory."*

Jerry Pournelle, BYTE: *"What I think the computer industry is headed for: well documented, standard, plenty of good features, and a reasonable price."*

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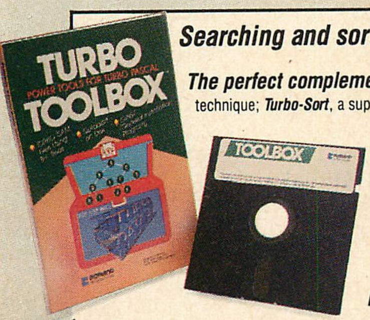

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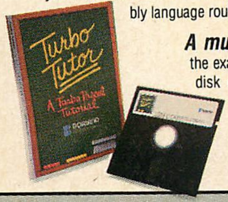

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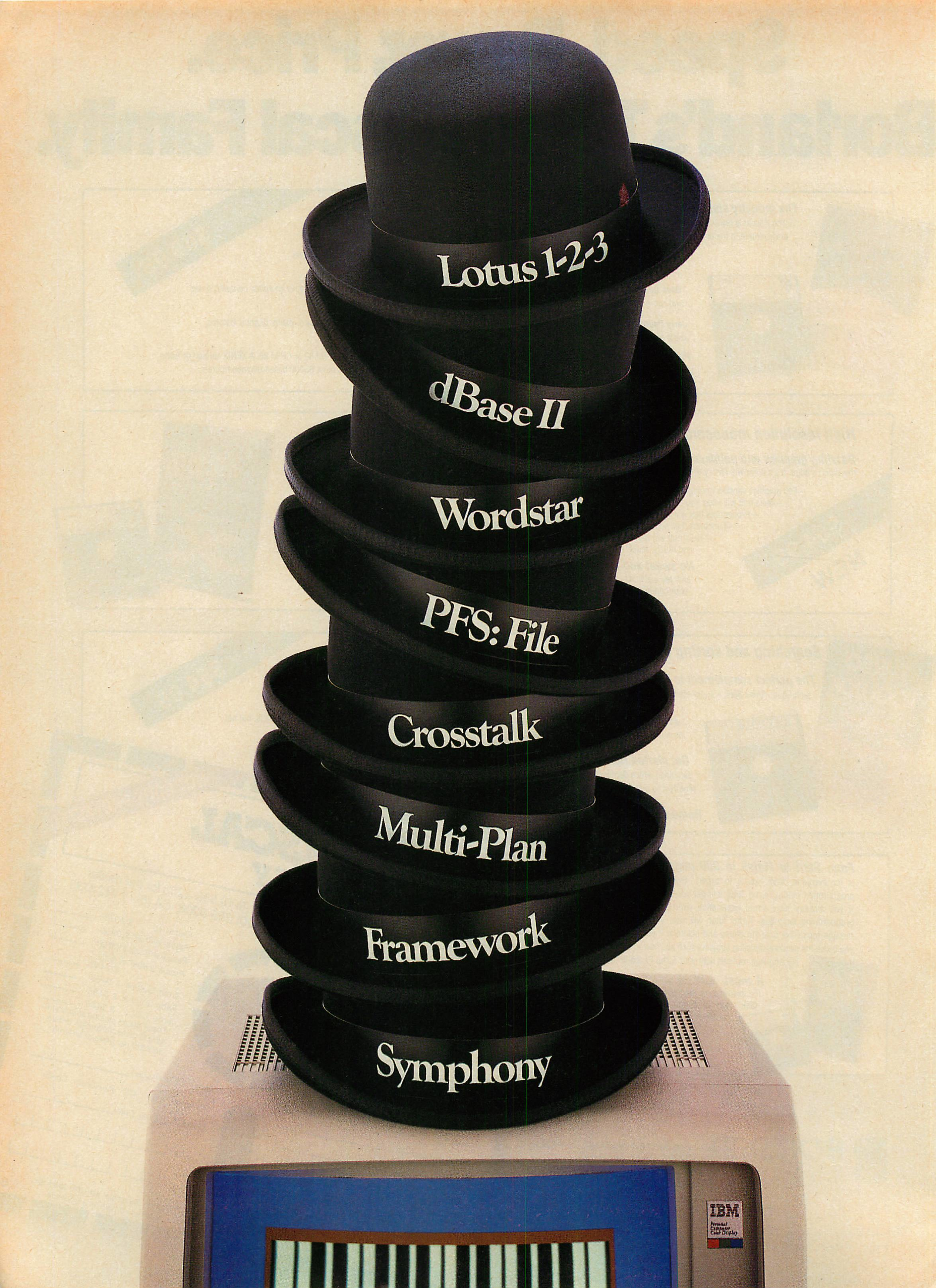
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TECH NOTEBOOK 40

JOHN FIGUERAS

Saving Space in Turbo

The use of .CHN files to compile programs in Turbo Pascal can save disk space and create user-friendly programs.

Turbo Pascal includes a compiler option, accessible from the main Turbo system menu, that permits generation of compiled code in three different modes: (1) in memory, (2) as a .COM disk file, and (3) as a .CHN disk file. The first option allows a program to be run immediately after it is compiled. The second allows a program to be run directly from disk simply by typing its name at the DOS prompt. The third option is used to chain from one program to another. A simple application of chained files in Turbo Pascal can save substantial disk space and increase flexibility.

The program shown below, called Run, drives a pseudo-operating system. It issues a prompt, "Run which program?" in order to get a file name, and then chains to the selected file by means of the final Chain command. Program Run is compiled to disk as a .COM file under the name R. Therefore, typing the letter *R* (either upper- or lowercase) at the DOS prompt executes the program Run, which issues the prompt, obtains user input, and then runs the selected module. The module must be present on the disk as a .CHN file. The only operational difference between this system and the usual mode of running .COM files is the required typing of *R* as an intermediate step in accessing a program.

At first glance, this procedure seems merely to have introduced a small inconvenience. The benefit to be derived however, is a large increase in free disk space.

Each .COM file carries with it the Turbo Pascal runtime library, which contains slightly more than 10KB of machine code. If 10 .COM files are on the disk, 90KB of disk space will be devoted just to replication of the runtime library. .CHN files, on the other hand, do not carry any Pascal library; they consist of program machine code only. However, the Pascal library must be available at least once. For this reason, the R module is a .COM file; it carries the runtime library, which is subsequently passed to any .CHN file that is accessed by the Chain command in the Program Run. This is the only copy of the Pascal library that appears on the disk; all the rest of the programs, which are .CHN modules, use this one copy. Not only is disk space released, allowing more files to be stored, but the smaller .CHN files also load faster.

The use of the driver program Run (as its disk image, R.COM) introduces some opportunities for writing user-friendly operating systems. For example, the driver program Run could be told to display all of the .CHN modules as a reminder to the user before issuing its prompt for module selection. In a chemical information system, I introduced a .CHN module, called CHEMFILE, that generates a menu from which any other program in the system can be selected—for example, SEARCH or DISPLAY. However, since SEARCH and DISPLAY are themselves .CHN files, they also can be accessed from the R command. Consequently, any module in the system can be accessed directly from the Run driver, or alternately can be obtained through the CHEMFILE menu. This has the advantage that novice users may approach the system through a menu, while experienced users for whom the menu is a nuisance may run modules directly.

Variables can be shared between the current program and .CHN files in two ways: by declaring *shared global variables* or by using *absolute address variables*. Shared global variables must be the first ones declared and must be listed in the same order in both programs. An absolute address variable is declared to reside at a specific memory address by using the reserved word *absolute*, followed by an integer address. For example, the declaration

DTA : Byte absolute $80

assigns the variable DTA to address 80H relative to the beginning of the program.

When .COM files are compiled in Turbo, the user may optionally indicate the amount of space required by program code and data, using the options command *O* for allocating code space and *D* for allocating data space. The module R.COM must have these parameters established for the *largest* .CHN module to which Run will chain, or the user will get a runtime error or aborted execution when R.COM attempts to call a chained program. The required size parameters are obtained from an ordinary compile to memory of the largest module, noting the reported parameters for code and data that are displayed when compilation is complete.

John Figueras is an assistant professor at the State University of New York at Geneseo in the computer science department. He retired after spending 20 years as a programmer at Eastman Kodak.

LISTING: RUN.PAS

```
Program Run;

{activate a chain file}

var
   FileName  : String[8];
   DiskFile  : file;

begin
   ClrScr;
   write ('Run which program? ');
   readln(FileName);
   assign(DiskFile, FileName + '.CHN');
   chain(DiskFile)
end.
```

TED MIRECKI

Keyboard Scan Codes

Identifying the scan codes for the PC keyboard is important for implementing a customized keyboard translation routine.

The IBM PC's keyboard is wonderfully flexible. None of the keys is hard-wired to send the code of the character or function imprinted on them—instead, each sends a scan code to indicate the position of that key. The meaning of each key is completely controlled by software.

Knowing the values of the scan codes is important for implementing a customized keyboard translation routine, say for a keyboard macro processor or for a word processor that needs to respond to cursor keys. Although the *IBM Technical Reference* includes a list of scan codes, it is incomplete. For example, the manual does not provide any codes for the Alt and numeric keypad combinations.

The KEYSCAN program, below, takes a keystroke as input and produces a four-character display of the form XXYY, where XX is the hex representation of the scan code, and YY is the ASCII code. The program is terminated by pressing Ctrl-Break (the scan code for which is 0000).

The main routine performs an INT 16H, which is a call to the routine that waits for keyboard input and translates scan codes to ASCII codes. Upon return, the two codes are converted to four hex characters, each in the range 0 through F. The characters are displayed with a DOS call, and KEYSCAN loops back for the next keystroke. Note that no test is needed for the Ctrl-Break combination, because DOS can handle this automatically. The keyboard input routine, upon detecting the Ctrl-Break combination, posts a break flag and returns to the caller, passing zeroes for both scan code and ASCII code. It is then up to the calling routine to process the break request. KEYSCAN simply ignores it, converts the zeroes to characters, and calls the DOS display function. The break flag is tested by the DOS screen output routine, and the program is terminated if the flag is on.

To try out KEYSCAN, create the source file with a program editor or word processor, assemble it with MASM, and create an .EXE file with the LINK program. Ignore the "Missing stack segment" message from LINK and convert the .EXE file to .COM format with EXE2BIN before running it. Instructions for doing this are provided in the DOS manual.

Ted Mirecki has a master's degree in computer science and 20 years of experience in information processing. He is a corporate planner and is responsible for developing decision support systems.

LISTING: KEYSCAN.ASM

```
COMMENT " Routine KEYSCAN returns scan code and ASCII code
          (if any) for each keystroke, until Ctrl-Brk.

Author:  Ted Mirecki  June 1984
ASMUTIL    SEGMENT BYTE PUBLIC 'CODE'
           ASSUME CS:ASMUTIL, DS:ASMUTIL
           ORG      100H
KEYSCAN    PROC
           JMP      SHORT PASTDATA
KEYCODE    DB       ?,?,?,?,0DH,0AH,'$'
MSG        DB       'Strike any key, Ctrl-Break to exit',0DH,0AH
           DB       '$'
PASTDATA:  MOV      DX,OFFSET MSG  ;ISSUE SIGN-ON MESSAGE
           MOV      AH,9
           INT      21H

GETKB:     SUB      AX,AX              ;READ THE KEYBOARD
           INT      16H                ;WAIT FOR KEYSTROKE
           MOV      DI,OFFSET KEYCODE  ;POINT TO CHAR AREA
           CALL     AX2HEX
           MOV      DX,OFFSET KEYCODE  ;DISPLAY HEX CHARACTERS
           MOV      AH,9
           INT      21H
           JMP      GETKB              ;GO GET NEXT KEYSTROKE
KEYSCAN    ENDP
ASMUTIL    ENDS

COMMENT " Routine AX2HEX converts value in AX to 4 hex chars.
Author:  Ted Mirecki  January 1984
     INPUT:  Value to be converted in AX.
             ES:DI points to buffer to receive characters
             (Length 4 bytes).
     OUTPUT: 4 hex characters (0 - F) in output buffer.
             DI points 1 byte past last character.
             AX destroyed, other regs unchanged.
ASMUTIL    SEGMENT BYTE PUBLIC 'CODE'
           ASSUME   CS:ASMUTIL
AX2HEX     PROC     NEAR
           PUBLIC   AX2HEX
           CLD                      ;GO FORWARD THRU STRINGS
           PUSH     BX              ;SAVE RESGISTERS
           PUSH     CX
           PUSH     DX
           MOV      BX,OFFSET HEX   ;POINT TO HEX DIGIT CHARS
           MOV      CX,4            ;WILL HANDLE 4 NIBBLES
NEXTNIBL:  ROL      AX,1            ;HI-ORDER NIBBLE TO
           ROL      AX,1            ;LO-ORDER OF AX
           ROL      AX,1
           ROL      AX,1
           MOV      DX,AX           ;SAVE IT IN DX
           AND      AL,0FH          ;ISOLATE LOW-ORDER NIBBLE
           XLAT     CS:HEX          ;TRANSLATE TO HEX DIGIT
           STOSB                    ;PUT HEX DIGIT INTO OUTPUT
           MOV      AX,DX           ;RECOVER AX VALUE
           LOOP     NEXTNIBL        ;REPEAT FOR 4 NIBBLES
           POP      DX              ;RESTORE REGS & EXIT
           POP      CX
           POP      BX
           RET
AX2HEX     ENDP
HEX        DB       '0123456789ABCDEF'
ASMUTIL    ENDS
           END      KEYSCAN
```

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J. EDWARD VOLKSTORF

FIELDing with BASIC

BASIC's FIELD statement has a few not-so-obvious uses.

The FIELD statement in BASIC assigns one or more string variable names to the input/output buffer associated with a file opened for random disk I/O. This statement can be put to use in ways that are not immediately obvious.

Listing 1 (below) creates MYFILE.DAT for random I/O with each record defined as 90 characters. A single record is set in the file. With the FIELD statement, the user easily can define certain portions of that record.

Multiple FIELD statements are coded in lines 110 through 130, defining the whole record, separate fields, and portions of a field. The variable REC.DAT$ is the whole record; NA$, AD$, and CS$ define name, address, and city/state/zip-code fields within the record.

The last field is further redefined in line 130 to allow accessing its individual elements: the city name, state name, and zip code. This is done by using a dummy (filler) field for the first 60 characters of the record. The key point to remember about the FIELD statement is that each time it is used it maps the disk buffer from the very beginning into the string variables that are used in the statement.

Redefinitions allow the user to access a field such as CS$, which consists of the last 30 characters in the record, symbolically instead of using MID$(REC.DAT,61,30). Furthermore, a new record can be cleared entirely to blanks as was done in line 135 of listing 1.

A dummy field, as shown in listing 1, can be used to map the disk buffer into a string array. If the user wanted to process each character in the above example, he could use the FIELD statement with an array that has been dimensioned to 90 elements. Lines 200 to 220 illustrate how this is done.

Subsequent statements using REC.CHAR$(K) now access the *Kth* character from the disk buffer for the last record that was read or written (from the last GET or PUT to this file) as shown in line 270 of listing 1.

This procedure can also be used to create a table of binary coded numbers that might be stored as records in a random file. Each record in a file contains 32 single precision numbers. A single precision number consists of 4 bytes, so each record contains 4 * 32, or 128, bytes. Listing 2 creates such a file, mapping each number into the array SP.NUM$.

The CVS function in line 230 converts the numbers from their internal binary format as stored in array SP.NUM$ to displayable ASCII. Unfortunately, the LSET statement cannot set values back into the files buffer via the arrays in these examples. For example, the following statement causes an error:

LSET SP.NUM$(23)=MKS$(3.14159)

A string variable must be used for the buffer inserting the value in that string using concatenation or the LET MID$ function. The updated copy is then used in an LSET statement to put it back in the file's buffer. This is done using random numbers in lines 150 to 190 in listing 2.

J. Edward Volkstorf is a freelance writer and consultant specializing in educational computing. He is the author of Graphics Programming on the IBM Personal Computer (*Prentice-Hall, 1984*).

LISTING 1: FIELDS1.BAS

```
100 OPEN "MYFILE.DAT" AS #1 LEN=90  ' a random I/O file
105 DIM REC.CHAR$(90)               ' array for characters
110 FIELD 1, 90 AS REC.DAT$         ' define entire record
120 FIELD 1, 30 AS NA$,
    30 AS AD$, 30 AS CS$            '   plus its fields
130 FIELD 1, 60 AS DUM$, 23 AS C$,
    2 AS S$, 5 AS Z$                '   and sub-fields
135 LSET REC.DAT$=SPACE$(90)        ' blank out record
140 LSET NA$="J Smith"
145 LSET AD$="123 A St."            ' set some fields
150 LSET C$="Baltimore"
153 LSET S$="MD"
155 LSET Z$="23456"                 '   and sub-fields
160 PUT 1,1                         ' save this record
170 GET 1,1                         ' retrieve it
200 FOR I=1 TO 90                   ' loop to define
210 FIELD 1, (I-1) AS DUMMY$,
    1 AS REC.CHAR$(I)               ' each character in record
220 NEXT I                          ' end of define loop
230 PRINT CS$                       '   here are 4
240 PRINT C$;S$;Z$                  '     ways to do
250 PRINT MID$(REC.DAT$,61,30)      '       the very
260 FOR I=61 TO 90                  '          same
270 PRINT REC.CHAR$(I);             '           thing
280 NEXT
```

LISTING 2: FIELDS2.BAS

```
100 DIM SP.NUM$(32)                    ' define array
110 OPEN "NUMBERS.DAT" AS #1 LEN=128   ' open file
115 FIELD 1, 128 AS NUMBR$             ' define entire record
120 FOR I=1 TO 32
130 FIELD 1, (I*4-4) AS DUMMY$,
    4 AS SP.NUM$(I)                    ' map into array
140 NEXT I
150 TN$=""                             ' for temp number storage
160 FOR I=1 TO 32
170 R=RND : PRINT R;
175 TN$=TN$+MKS$(R)                    ' pack RND into string
180 NEXT
190 LSET NUMBR$=TN$                    ' move to file buffer
195 PUT 1,1                            ' save the record
200 GET 1,1                            ' and retrieve it
210 PRINT : PRINT
220 FOR I=1 TO 32                      ' for each number
230 PRINT CVS(SP.NUM$(I));             ' re-print the RND values
240 NEXT                               ' end of loop
```

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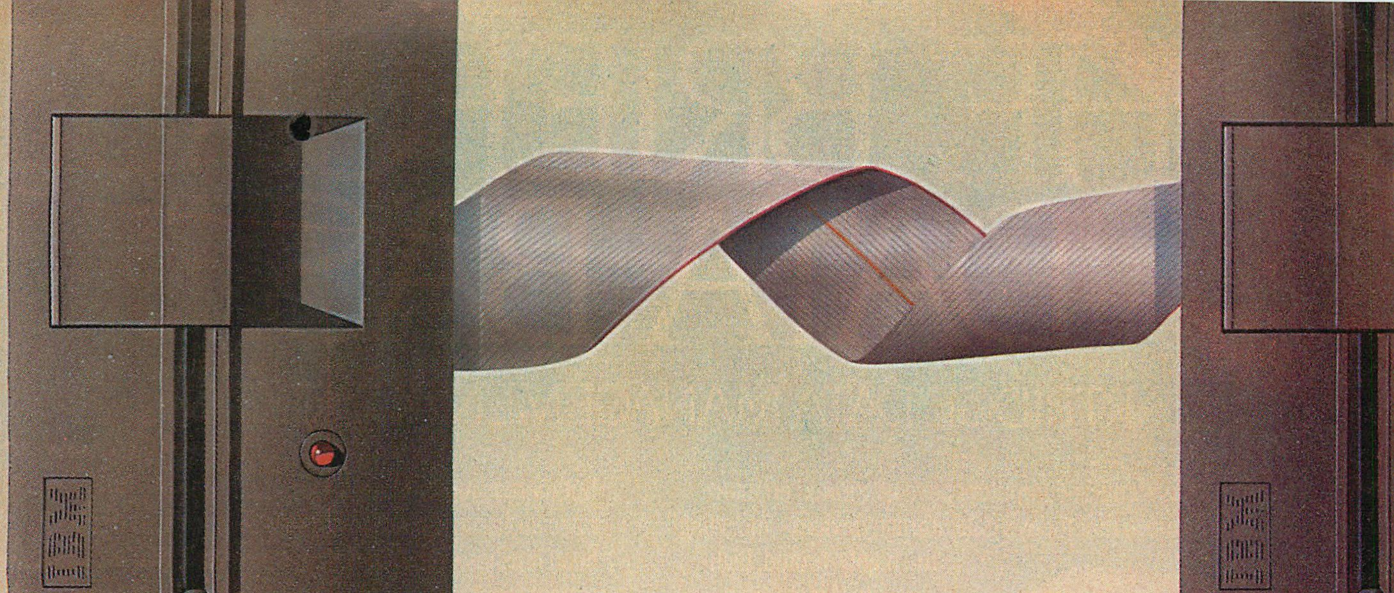
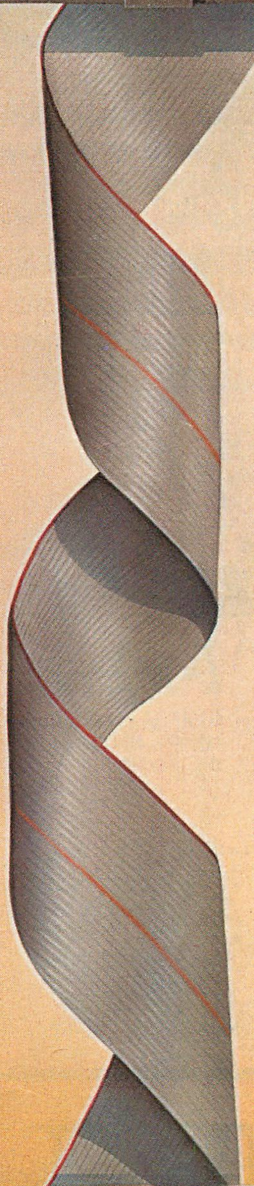


JACK WRIGHT AND DAVID ZARODNANSKY



The Third Drive

Adding another floppy disk drive to a system provides some hard disk advantages at a lower price.

Users who are still without a hard disk for one reason or another might want to consider adding a third or even a fourth floppy drive to their systems. To a certain degree, the additional disk will provide one of the advantages of a hard disk—permanent on-line program storage. If the system to be upgraded has an extra drive (even if it is an old, seemingly useless, single-sided drive), another drive can be added inexpensively. If a drive must be purchased, many mail-order sources have them for less than $129.

Why are three drives better than two? Because the third one can hold a disk permanently containing frequently used utility programs, making them always instantly available. This cuts down dramatically on disk shuffling. The third drive, for example, could hold often-used DOS external commands, a full-screen editor, a printer-control program, BASIC, Prokey, a few help files, and other utilities. The PATH command (in DOS 2.0 and later) can be set to search the extra drive, so that typing the drive letter is not necessary to access the programs.

Another nice feature of having three drives on a system is the insurance that it provides in case one of the drives should start performing abnormally—such as producing the "Abort, Retry, or Ignore" message a little too often. If one drive goes down, then two others will still be usable while the third one is out being repaired.

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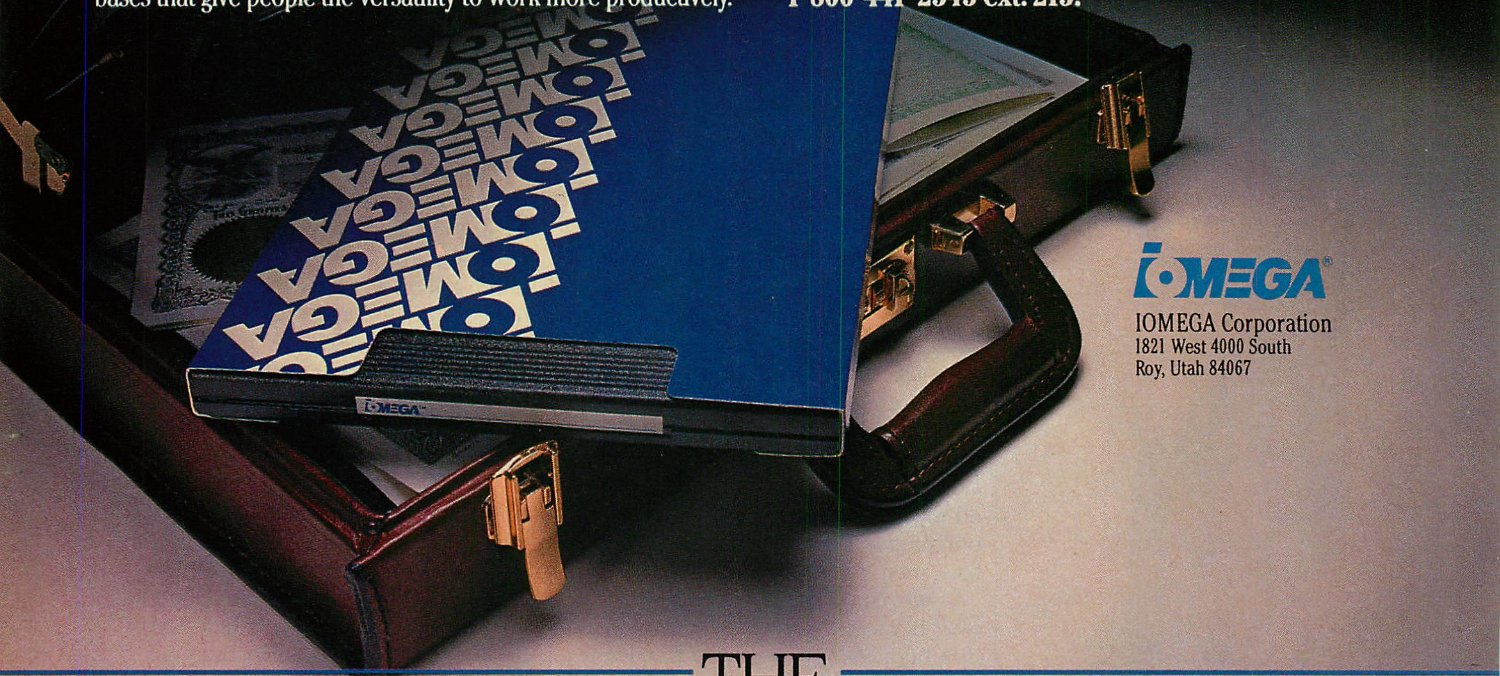

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Yet another reason for adding an external floppy drive is the noisiness of the system unit. Adding an external floppy drive to a hard-disk system makes it possible to shove the PC into a nearby closet or behind a partition, leaving only the keyboard, CRT, and external floppy (all on extension cables) on the desk. With most files existing on the hard disk, the need for physical proximity to the system unit is greatly reduced. The XT-style, 135-watt power supply is a good deal noisier than the PC's smaller 63.5-watt supply. Putting any distance at all between the work space and the 135-watt supply could spell the difference between mild irritation and total distraction.

If the PC's power supply is used for the extra drive, the additional power required by another disk drive should not be a concern, because only one drive motor is on at any one time.

When leaving a floppy permanently in the C: drive, it is probably a good idea to open the drive door each time the PC is turned off to relieve hub stress and head pressure on the disk and remove the heads from the disk surface. Some people say that powering a computer up or down with the drive heads in contact with a disk can ruin the disk. Others claim that built-in safeguards within the drive mechanism prevent damage, and leaving drive doors closed during power up or down will have no effect. Although we have never had a disk damaged in this way, the issue is apparently still open.

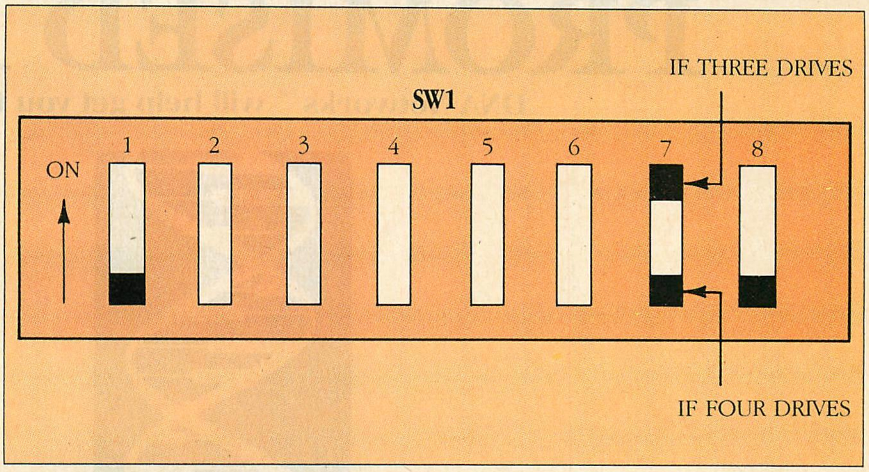
All of the required circuitry for two additional floppy-disk drives is already in place on the IBM disk adapter card. All that is necessary to add external disk drives is to follow the four steps explained below.

Setting up the system board. The first step is to take the cover off the PC and find the system board DIP-switch SW1 near drive A: (see the *Guide to Operations* or the *Technical Reference* manuals). Set it as shown in figure 1. If the system has two drives, switch position 1 will already be set correctly.

Note that the setting is for the total number of *floppy-disk* drives, not RAM disks or hard disks. An exception to this is the AST RAM disk program (provided with all of the AST memory cards), which requires SW1 to be set to include its RAM disk. Trying to use four floppies and the AST RAM disk can obviously cause a problem. In this case, the DOS 2.0/2.1 RAM disk program should be used instead of the AST one.

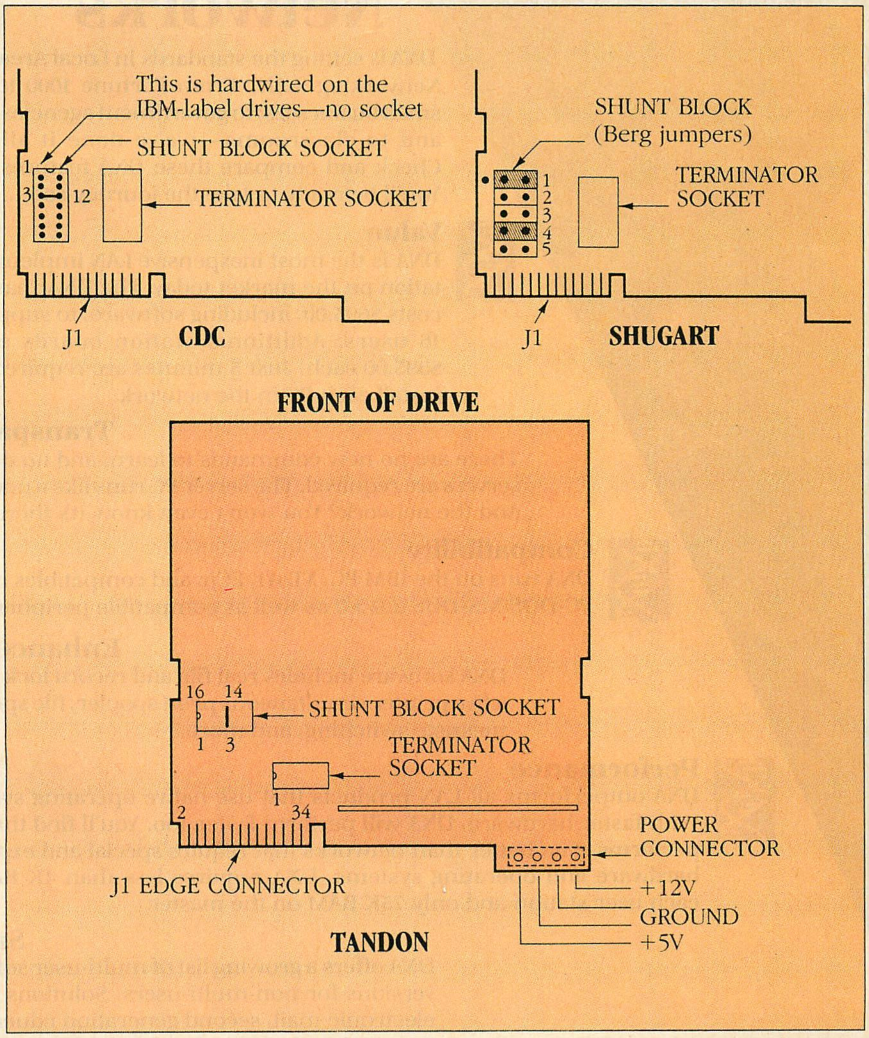
The DOS program is the "Sample Device Driver" listed in the DOS 2.0

FIGURE 1: *System Board SW1 Settings*



The system board DIP-switch SW1 is located near drive A:. If the system has two drives, switch position 1 will already be set correctly.

FIGURE 2: *Shunts and Terminator Blocks*



The shunt block and DIP terminator are handled differently on drives from different manufacturers. The shunt block socket may have 14 or 16 pins. Virtually all floppy-disk drives have a terminator socket, but some, such as the IBM-label CDC drives, have the shunt block jumpers hardwired onto the printed circuit board.

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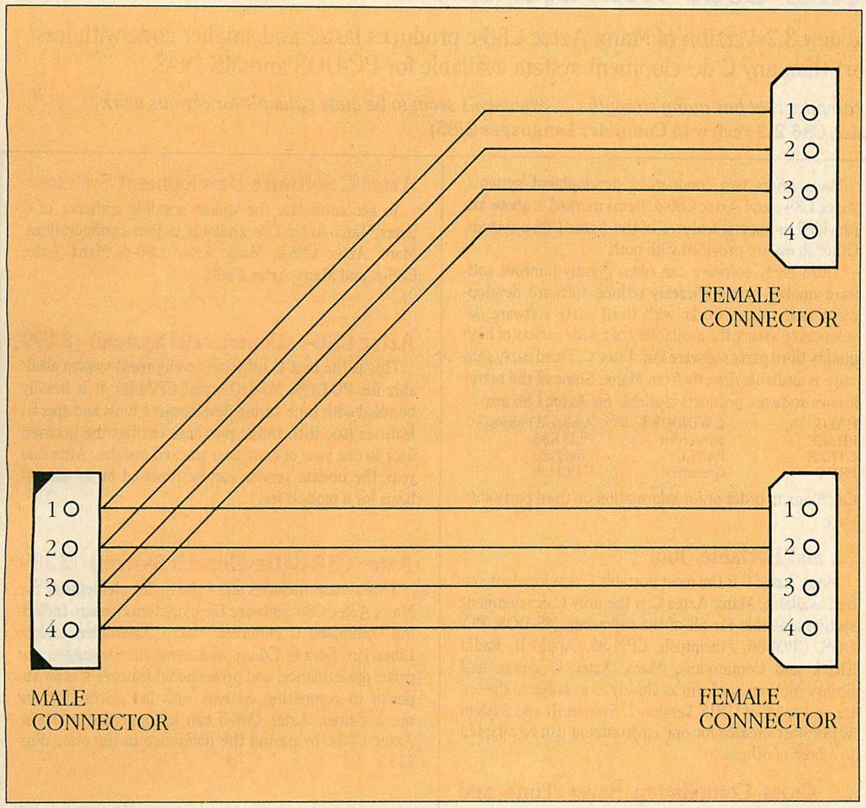
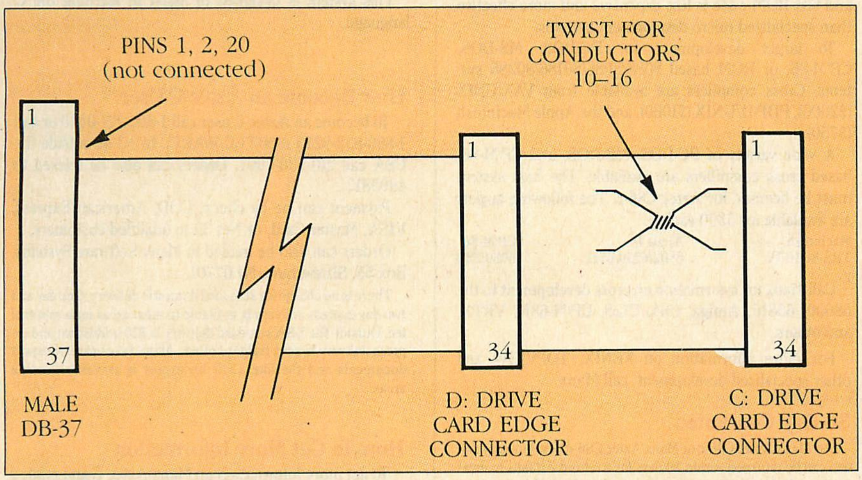
FIGURE 3: *Y-cable for Drive Power*



One Y-cable will be needed between the power supply cable and drive A: to bring power to the exterior of the PC system unit.

FIGURE 4: *External Drive Data Cable*



Conductors 10-16 must be separated from the cable as a group and given a twist before being inserted into the C: drive connector.

manual in chapter 14 (pages 14-27 in the DOS 2.0 manual or pages 3-27 in the DOS 2.1 *Technical Reference* manual). In DOS 3.0, the program, called VDISK.SYS, is already on the DOS disk. If DOS 3.0 is not available and typing the program in from the DOS 2.0 manual looks unappealing, the program can also be found in various forms on many bulletin board systems or in many IBM PC user-group disk libraries.

The DOS program is installed by including the line "DEVICE = prog name" in the CONFIG.SYS file on the boot-up disk; "prog name" is the name of the RAM disk program. If the system contains three floppy drives, the program will install as drive D: (with four, it will automatically become drive E:).

Setting up the disk drive. On the circuit board on the top of the disk drive are two IC sockets. One contains a DIP shunt and the other has a terminator IC. Figure 2 is correct for the Tandon drives, CDC, and the Shugart half-heights; other drives may look slightly different but at least will have the socket terminator IC. If the drive has been used in a PC before, then the DIP shunt very likely has been set up correctly.

The terminator IC in one of the sockets is usually light blue in color. If both a C: and a D: drive are being added, remove the terminator IC from the D: drive. Drive C: must have a terminator IC installed; drive D: must not.

The DIP shunt should be configured so that all of its connections are open except for the connection between pins 3 and 14 (pin 14 will be directly across from pin 3—see figure 2). On the CDC drives, this is only a 14-pin socket, so the connection should be between pins 3 and 12. Some drives are shipped with all shunt connections shorted—be sure to open all of them except the shunt connection between pins 3 and 14 (pins 3 and 12 on the CDC). The IBM-label CDC drives do not have the shunt socket—the connections normally routed to the shunt socket are hardwired. The Shugart drives have a different arrangement (see figure 2).

Making the power cables. The connector that is used for supplying power to the disk drives is a 4-pin connector (see figure 2 for location). The disk drive has the male end mounted on the PC board, and the female end is on the cable. Therefore, to tap into this connector to extend power to an external drive, a Y-cable, such as the one shown in figure 3, must be constructed or purchased. Note that IBM's warranty will not cover any damages resulting from home-made cables.

The connectors are assembled onto 18-gauge wire (using smaller wire is not a good idea). One Y-cable will be needed between the power supply cable and drive A: to bring power to the exterior of the PC system unit. A long cable with a male plug on one end and a female receptacle on the other may then be used to bring power over to the enclosure containing the external drives. If two external drives are to be powered, a second Y-connector may be used to supply power to both drives.

The AMP stock number for a complete set of one male and one female drive power connector is 605773-1.

A ready-made cable (called a drive power Y-connector cable) may be ob-

AZTEC C

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"A compiler that has many strengths ... extensions seem to be quite valuable for serious work"
(Aztec C86 2.2 review in Computer Languages 2/85)

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Manx Aztec C86-c produces code that executes up to 60 percent faster in up to 60 percent less space than code produced by other PC-DOS and MS-DOS compilers. In short, it generates the best code available.

An extract from the C benchmark comparison in the January, 1985 issue of Computer Languages is reproduced here. Aztec C86-c clearly generated the best code. Modifying the sieve benchmark to use register variables presents an even clearer picture. Aztec C86-c executes in 6.51 seconds, Mark Williams executes in 7.56 seconds, and there is no improvement for Lattice and Computer Innovations Optimized C86. The Dhrystone benchmark results presented here are from a benchmark study conducted by MANX. The Dhrystone benchmark was published in the CACM (10/84 27:10 p1013) and converted by MANX from ADA to C. The Dhrystone benchmark was designed to produce a figure of merit for performance for systems software. For a full copy of the Manx Dhrystone and Whetstone benchmarks including timings for large memory models call Manx.

	Execution Time	Code Size	Compile/ Link Time
Sieve Benchmark			
Manx Aztec C86 2.2	11 secs	4,448	64 secs
Lattice 2.13	11 secs	21,902	98 secs
Mark Williams 2.0	12 secs	6,887	79 secs
Optimized C86 2.20G	13 secs	12,729	111 secs
Matrix Benchmark			
Manx Aztec C86 2.2	16 secs	7,804	92 secs
Lattice 2.13	29 secs	25,176	163 secs
Mark Williams 2.0	29 secs	10,847	107 secs
Optimized C86 2.20G	27 secs	13,766	134 secs
Dhrystone Benchmark			
Manx Aztec C86 2.2	36 secs	5,680	93 secs
Lattice 2.14	89 secs	20,404	117 secs
Mark Williams 2.0	56 secs	12,980	113 secs
Optimized C86 2.20J	53 secs	11,009	172 secs

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At Manx, we understand the value of development tools, specialized features, professional documentation and technical support in making it easier for you to produce quality software. That's why we bundle more than $1000 worth of special features and tools with Manx Aztec C86-c, provide documentation that wins consistent praise for its clarity and completeness, and provide telephone access to experienced technical support for all Manx Aztec C products.

The following are some of the more important components of the Manx Aztec C86 Software Development System. Notice that many of the features that are bundled with Manx Aztec C86-c such as the debugger, Z editor, macro assembler, library source code, and ROM support are extra cost items with other systems.

Optimized C compiler	Symbolic Debugger
AS86 Macro Assembler	C Utility Library
LN86 Overlay Linker	DOS Function Library
Z (Vi) Source Editor-c	8087/80287 Sensing Lib
ROM Support Package-c	80186/80286 Support
Graphics Library	INTEL HEX Utility-c
CP/M-86 Library-c	Librarian
Screen Library	Graphics Library
Extensive UNIX Library	Object File Utilities
Library Source Code-c	Mixed memory models-c
Microsoft/Intel Object Option	Lattic, Microsoft, and CI-C86 Interface
Small and Large memory models	Unitools (MAKE, DIFF and GREP)-c

Manx offers two commercial development systems, Aztec C86-c and Aztec C86-d. Items marked -c above are provided as special features of the Aztec C86-c system. Other items are provided with both.

Third party software can often greatly improve software quality or significantly reduce software development time. Manx works with third party software developers to assure the availability of a wide variety of high quality third party software For Aztec C. Third party software is available directly from Manx. Some of the better known software products available for Aztec C86 are:

HALO	C WINDOWS	Amber Windows
PHACT	Sunscreen	PLINK86
C-TREE	PANEL	FirstTime
PRE-C	Greentree	C Util Lib

Call Manx to order or for information on third party software.

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Manx Aztec C is the most portable C development system available. Manx Aztec C is the only C development system available for all of the following: MS-DOS, PC-DOS, CP/M-86, Macintosh, CPM-80, Apple II, Radio Shack and Commodore. Manx Aztec C syntax and library routines conform as closely as possible to the letter and spirit of UNIX Version 7, System III and System V. Software created for one environment can be adapted to a host of others.

... Cross Compilation Saves Time and Resources

A comprehensive set of Cross compilers are available from Manx. Cross compilers allow development for a number of machines to be performed on a single faster host machine. Code is then downloaded and tested on the target machine. In some cases testing can also be done on the host machine. Using a PC or AT to produce and test ROM code is less expensive and more effective than specialized micro development systems.

To target development for PC-DOS, MS-DOS, CP/M-86, or ROM based 8088/8086/80186/80286 systems, Cross compilers are available from VAX/UNIX ($2000), PDP-11/UNIX ($1000), and the Apple Macintosh ($750).

A wide variety of PC-DOS, MS-DOS, and CP/M-86, based cross compiliers are available. The host system must be licensed for Aztec C86-c. The following targets are available for $300 each:

Macintosh	Apple II	CP/M-80
TRS-80 III/IV	6502/6510/6511	8080/Z80

Call Manx for information on cross development to the 68000, 65816, Amiga, C64, C128, CP/M-68K, VRTX, and others.

For more information on XENIX, TOPVIEW and other specialized development, call Manx.

30 Day Guarantee

Any Manx Aztec C86-c or Manx Aztec C86-d development system can be returned within 30 days for a refund if it fails to meet your needs. Restrictions are that the original purchase must be directly from Manx, and shipped within the USA. Returned items must be received by Manx within 30 days. A small restocking fee may be required.

Discounts

There are special discounts available to professors, students, and consultants. A discount is also available on a "trade in" basis for users of Lattice C, CI-C86, Mark Williams C, Wizard C, Digital Research C, and Microsoft C. Call Manx for details.

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To accommodate the widest possible audience of C users, Manx Aztec C is available in four configurations. Manx Aztec C86-c, Manx Aztec C86-d, Manx Aztec C86-p, and Manx Aztec C86-a.

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This is the best C software development system available for PC-DOS, MS-DOS, and CP/M-86. It is heavily bundled with time saving development tools and special features (see list). Initial purchase entitles the licensed user to one year of computer tracked updates. After one year, the update service can be renewed on an annual basis for a modest fee.

Aztec C86-d (Developer's System) $299

This system includes all of the major elements of the Manx Aztec C86 Software Development System. Including Optimized C compiler, Macro Assembler, Linker, Librarian, Source Editor, and Symbolic Debugger. For price, performance, and professional features it is far superior to competing systems with list prices that are much higher. Aztec C86-d can be upgraded to Manx Aztec C86-c by paying the difference in list price plus $10.

Aztec C86-p (Personal System) $199

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Aztec C86-a (Apprentice System) $99

This system is designed to assist in learning the C language.

How Become an Aztec C User

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Payment can be by check, COD, American Express, VISA, Master Card, or Net 30 to qualified customers.

Orders can also be mailed to Manx Software Systems, Box 55, Shrewsbury, NJ 07701.

There is no charge for standard domestic delivery. One day and two day express delivery is available to most areas for a minimal fee. Outside the USA standard delivery is $20 additional and express delivery is sent freight collect. Manx takes care of export documents and the like. COD on export is available to some areas.

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CIRCLE NO. 208 ON READER SERVICE CARD

tained for $8 from Floppy Disk Services. This company offers a great many add-on floppy-disk and hard-disk products (see the accompanying sidebar).

The cable is constructed such that each of the pins on each connector is in parallel with the corresponding pin on the other connectors, as illustrated in figure 3. The connectors are keyed, so that the cable cannot be plugged in incorrectly; make sure, however, that the connections are made correctly when the cable is constructed—there are no provisions for improper connections on the drives, and they *will* be damaged if the 5-volt pin is accidentally connected to the 12-volt source.

Connecting the drive. The standard IBM disk controller is capable of controlling four floppy drives. The first two drives (A: and B:) are internal and are connected to the controller card by means of a 34-pin card edge connector on the front (as the card is mounted in the system unit) of the card.

The second pair of drives is connected to the controller by means of the DB-37 female connector seen at the rear of the card. The easiest way to make a connection to the card is to use a DB-37 male connector that is designed to accept flat ribbon cable, such as the amphenol 841-17-DFCR-B37P.

Because only 34 of the 37 pins are used (pins 1, 2, and 20 are not used), 34 conductor ribbon cable will serve nicely to connect the drives. A cable such as 3M 3302, on which each conductor is shown in a different color, will help prevent mistakes in installing the connectors on the cable.

In addition, one 34-pin flat-ribbon-cable-type card edge connector, such as a 3M 3463-001, will be needed for each drive that is to be connected.

Construction of the drive-to-controller cable begins by cutting the end of the ribbon cable squarely off. It should be cut with a sharp instrument (tinsnips work well) so that no "whiskers" are pulled from the cut ends of the individual multistranded wires. Such "whiskers" can contact others pulled from adjacent wires and cause nearly invisible short circuits. Cutting the cable squarely will provide the best chance of getting a good connection when the DB-37 cable is attached. It is good insurance at this point to put tape on the end of the ribbon cable in order to eliminate the possibility of the cable end shorting to the connector.

If multicolored cable is used, the cable should be placed so that the brown conductor (#1) is to the right. The *back* piece of the DB-37 connector goes on top of the cable so that the left edge of the cable is flush with the left edge of the back piece of the connector—that is, so that pins 1, 2, and 20 of the connector will not be connected to the cable. The connector then can be put on top of the cable and back piece, pressing firmly. They must be aligned.

This type of connector is designed to be assembled in a press, but it can be done with a hammer if a female connector of the same type is mated with the male and the connector rear section is *gently* tapped into place with a hammer. Tapping too hard can crack the connector. Insulation displacement connectors such as these can also be assembled in a large bench vise, with the vise acting as a press.

To prepare the other end of the cable, place one of the card edge connectors on the cable about eight inches from the other end of the cable, making sure that pin 1 of the edge connector is connected to the same conductor of the cable as pin 21 of the DB-37 (if multicolored cable is being used, this conductor will be brown). Remember, pins 1, 2, and 20 of the DB-37 are not connected to anything.

Press this connector firmly onto the cable, and use the hammer (gently) to tap the back section onto the connector. This will be the connector for the D: drive. If only one extra drive is being added, this connector will not be necessary, but it is recommended that enough cable be included at this time so that a fourth drive can be easily added in the future. The drive-to-controller cable is shown in figure 4.

To place the connector for the C: drive, carefully slice (with a razor blade) through the webbing between conductors 9 and 10 and again between conductors 16 and 17, at least three inches back from the end of the cable. The section of the cable between conductors 10 and 16 should be turned over so that conductor 10 is next to 17 and conductor 16 is next to 9. This is done because IBM prefers to address the drives in software so that all drives are in the same hardware configuration, yet can be separately controlled.

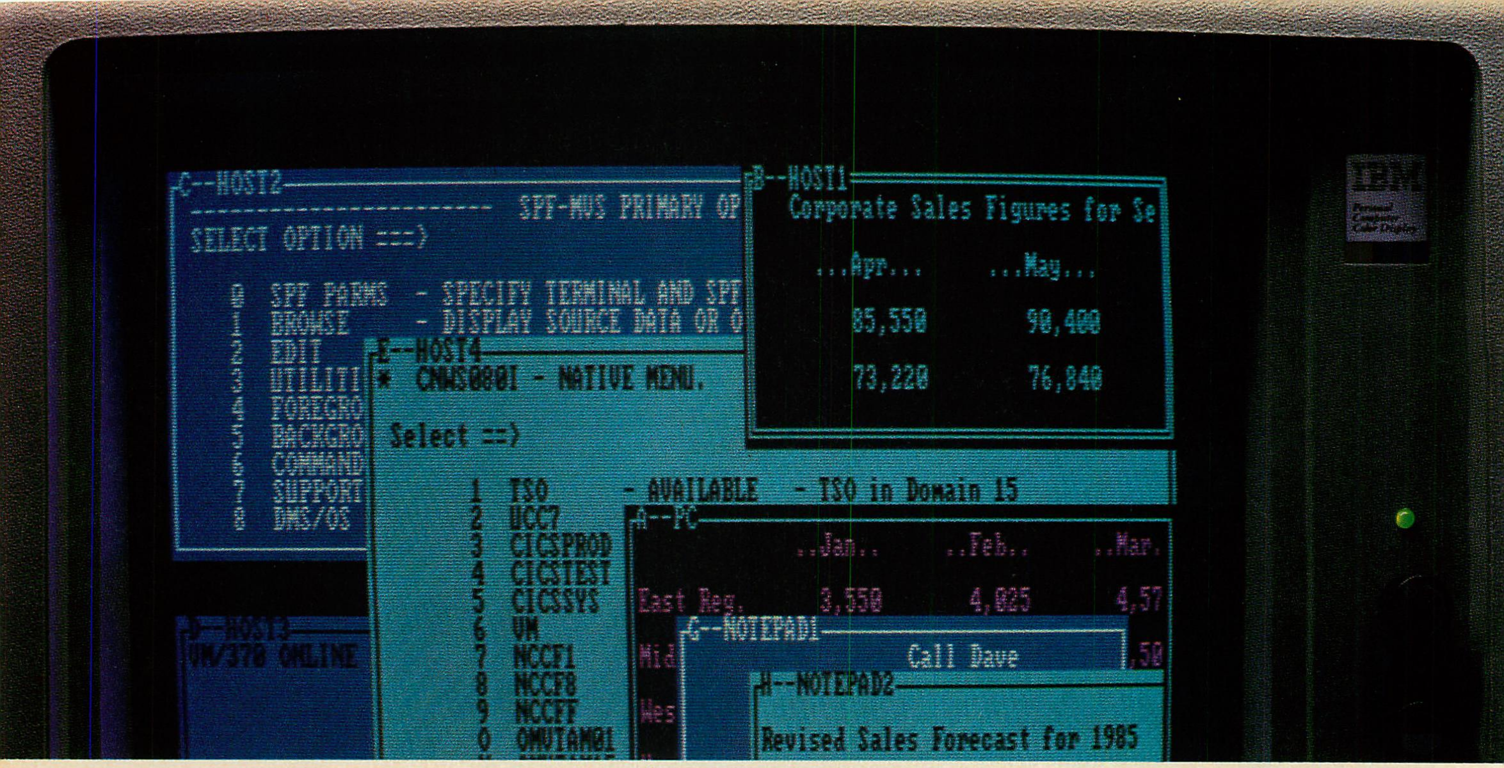
Now place the other connector on the end of the cable, again making sure that pin 1 on the connector goes to the conductor that is connected to pin 21 of the DB-37 connector, and press the back onto the connector. Use the hammer to tap on the back of the connector; the cable is assembled.

Like the power cable, this External Disk Drive Cable can be purchased already assembled.

TABLE 1: *Cable Connections*

CONTROLLER PIN	CONNECTION TO D:	CONNECTION TO C:	SIGNAL
1	N.C.	N.C.	Unused
2	N.C.	N.C.	Unused
3	2	2	Unused
4	4	4	Unused
5	6	6	Unused
6	8	8	Index
7	10	16	C: Motor run
8	12	14	D: Select
9	14	12	C: Select
10	16	10	D: Motor run
11	18	18	Stepper direction
12	20	20	Stepper pulse
13	22	22	Write data
14	24	24	Write enable
15	26	26	Track 0
16	28	28	Write protect
17	30	30	Read data
18	32	32	Sel. head 1
19	34	34	Unused
20	N.C.	N.C.	Gnd (controller end)
21-37	All odd pins	All odd pins	Gnd (both ends)

Disk-to-controller connections. Note that there is not merely an offset of 3 between the pin numbers for the drive and those for the controller



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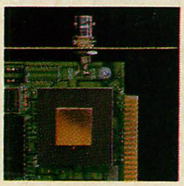

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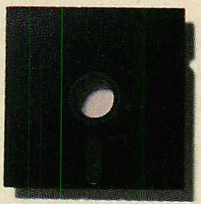

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CIRCLE NO. 112 ON READER SERVICE CARD

The controller connection is made by inserting the DB-37 male into the female DB-37 connector on the back of the controller card and connecting the card edge connectors to the drives. The connector on the end of the cable goes to the C: drive, and the one before the twist in the cable goes to the D: drive. The cables inside the PC have keys to prevent them from being put on the drives upside down; the cable just constructed does not.

The cables should be put on so that the even pins are on the top of the board on the drive, because all of the odd pins are grounded at both the drive and controller board. It should be pointed out, however, that there is not merely an offset of three between the pin numbers for the drive and those for the controller; instead, the connections are as shown in table 1.

Installing a third drive is as simple as that. If desired, sturdy steel drive enclosures for one, two, or four half-height floppy drives, such as the Teac FD55B, can be purchased from a number of sources (see sidebar). Add-on external floppy disk drives do not have to look sloppy or cost a fortune.

Jack Wright is involved in hardware and software development for RCA's David Sarnoff Research Center. David Zarodnansky works in the Information Systems Planning and Computer Services section at the center.

DISK DRIVE SOURCES FOR DO-IT-YOURSELFERS

For those willing to scour the magazines for sales and order products through the mail, raw materials are plentiful for PC disk-drive expansions of every size and flavor. Shop carefully, and consider group purchases: getting together with 20 other members of a user group will often shave another 10 to 15 percent off an already discounted price.

Prices for the slim, rugged, and power-efficient Teac FD55B half-height drive hover just above $100. (This drive costs $99 from PCs Limited, a company that also sells a 135-watt XT-style power supply for $119.) And those 20MB internal hard drive subsystems can be purchased for as little as $765 from Statewide Microelectronics; this company also sells a 10MB hard-disk system for $499. Streaming tape backup units of 10MB, which occupy the same "form factor" as a half-height 5.25-inch disk drive (and connect to the floppy controller card), are available for $595 from PCs Limited.

Floppy disk drives and 10MB or 20MB hard-disk subsystems have become PC commodity items in recent months. They are not, however, the last word in external storage for the PC. Eight-inch floppy disk drive subsystems are available from a number of vendors. Maynard Electronics offers a complete eight-inch drive subsystem, including DOS 2.x device drivers, case, power supply, controller, and cables, for $1,295. Similar, if more expensive, eight-inch systems are offered by Tecmar and Flagstaff Engineering. Maynard Electronics also manufactures a piggyback module for its SandStar series of controller boards, which allow control of hard disks. If slots are at a premium, Maynard has a card that combines both floppy- and hard-disk controllers in a single slot.

The last word in disk-drive controllers could well be Advance Logic Research's Advance Floppy Controller, which controls 5-inch, 8-inch, and PC/AT style 1.2MB floppy drives. In addition, it contains an AST-compatible clock/calendar, parallel port, and RS-232 serial port. The controller board is $199, and a 1.2MB floppy-disk drive from the same vendor is $250. Because this board can handle every floppy-disk format supported by any version of PC-DOS, it could be very handy for people or organizations (user groups, for example) who must juggle software libraries for diverse computer configurations.

Floppy Disk Services has made a specialty of mass storage for the do-it-yourselfer. The company offers all manner of PC disk drives and complete disk systems, external fixed-drive systems, streaming tape, power supplies, cabinets, and cables. It is also one of the few mail-order houses that enthusiastically does custom work; the technicians there can assemble virtually any desired floppy or hard disk system to order.

Mail order is not the only way to find disk-drive components at a discount. Many of the companies mentioned in this sidebar travel to periodic computer shows around the country, along with a horde of small firms that do business no other way. Keep an eye on local fairground and exhibition hall schedules. Also, attend "hamfests," which originated as flea markets for used ham radio gear but are now dominated by discount and used computer merchants. Shopping this way often allows you to see a drive operate before you buy it—some vendors will hook a disk drive to cables brought through the rear of a PC and allow DOS to be booted up from the drive.

Finally, for people who need to digest IBM format half-inch mag tape, there are outboard reel-to-reel tape drive systems from IBEX Computer Corporation. These systems generally communicate with the PC via RS-232 ports, so they are not speedy—and, at $5,950 they could well cost more than the entire PC. But if you need one, you need one. And that's what the add-on game is all about.

—JEFF DUNTEMANN

Advance Logic Research
23532 El Toro Road, Unit 6
El Toro, CA 92630
714/380-7798
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Flagstaff Engineering
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Floppy Disk Services
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Tecmar
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Cleveland, OH 44139
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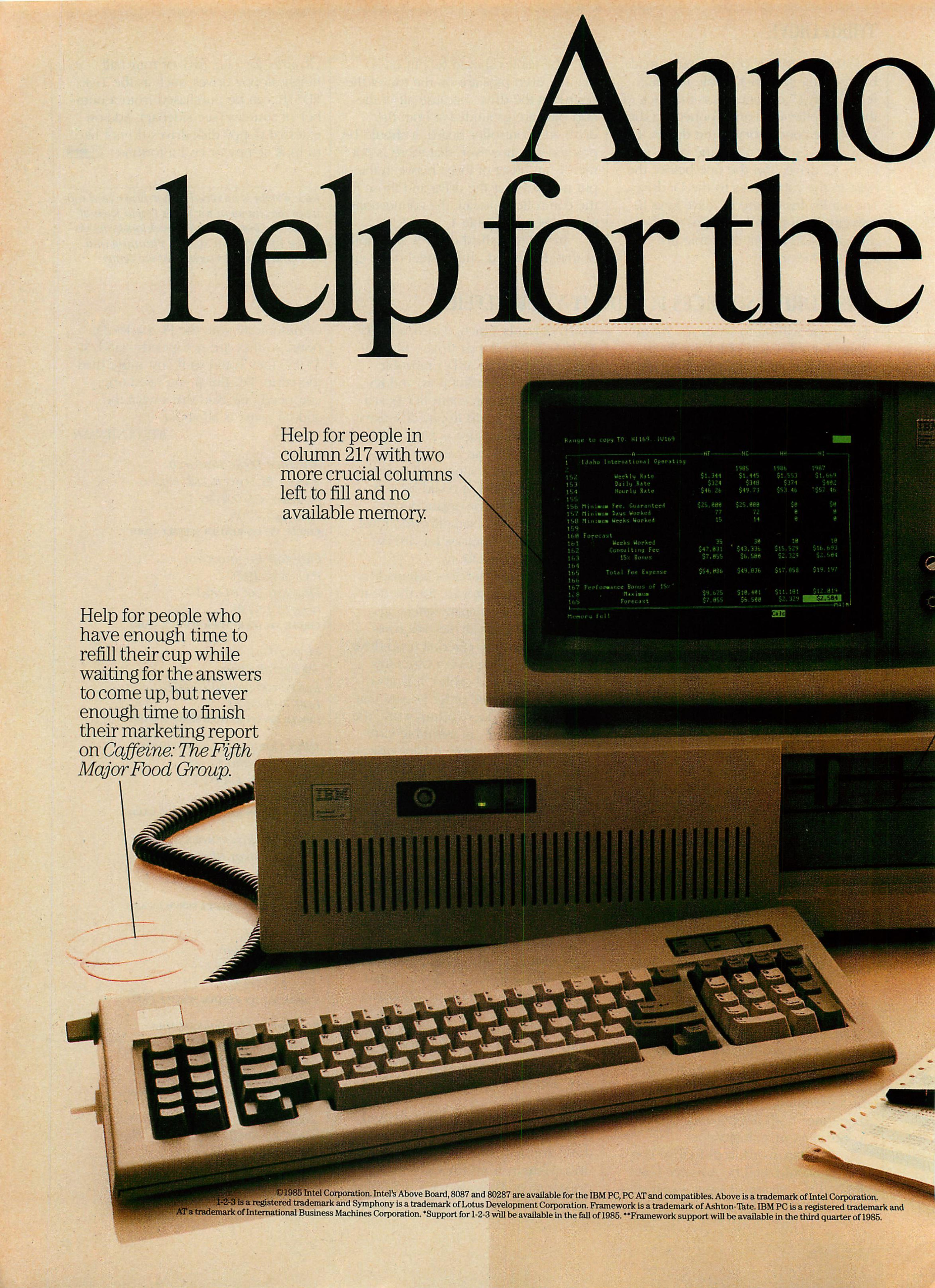

Anno
help for the
Help for people in column 217 with two more crucial columns left to fill and no available memory.
Help for people who have enough time to refill their cup while waiting for the answers to come up, but never enough time to finish their marketing report on *Caffeine: The Fifth Major Food Group.*
IBM
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uncing overachiever.

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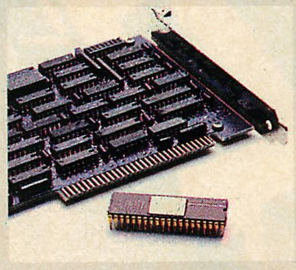

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COBOL Performs

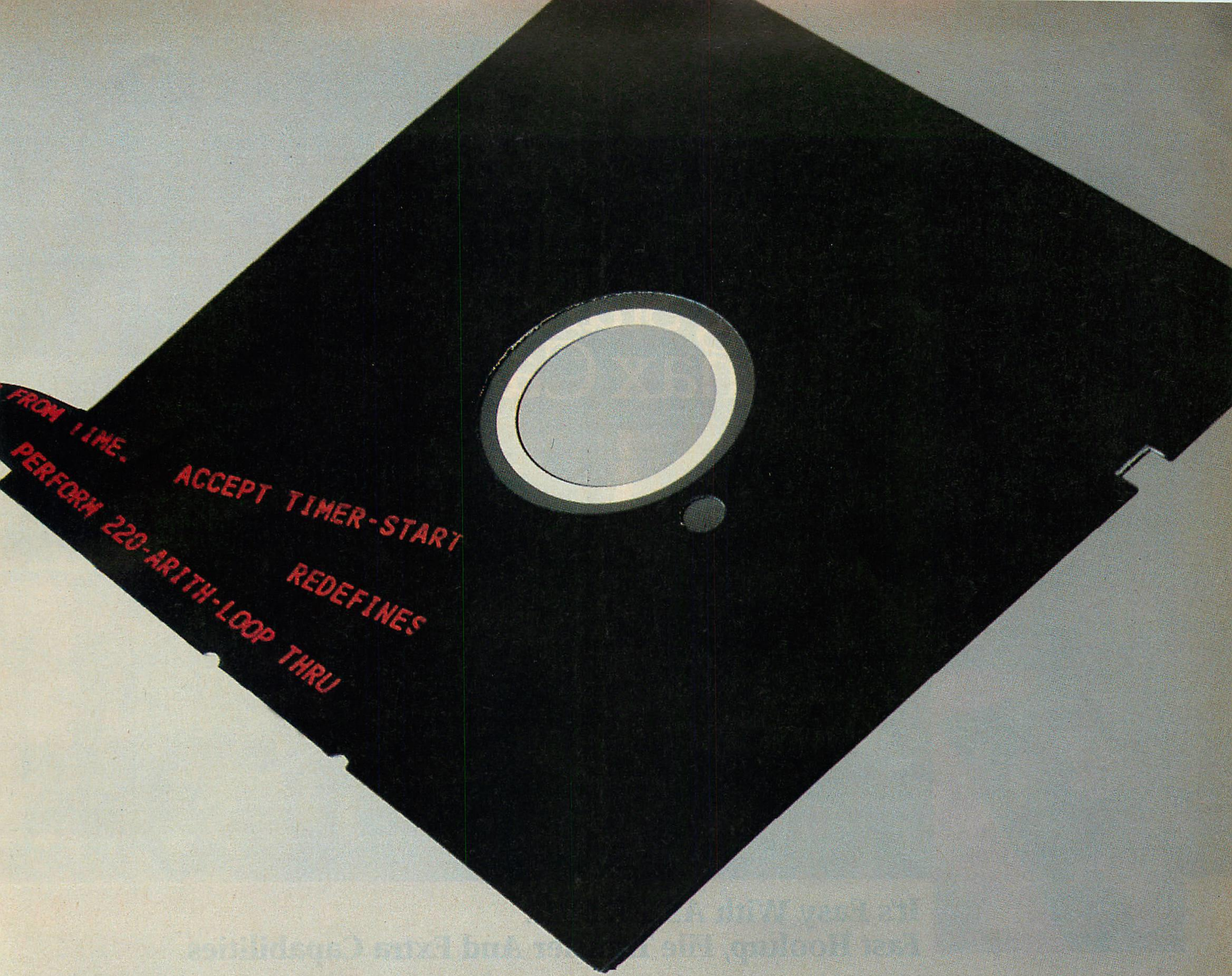
TED MIRECKI

The complexities and capabilities of this old, but highly usable, language find many levels of implementation in the microcomputer world.

This is the first of three articles that will survey current COBOL compilers for the IBM PC. The series begins with a review of two compilers: RMCOBOL from Ryan-McFarland and Realia COBOL.

In the past COBOL has been the recipient of some very bad press. The gurus of computer science heap invective on this "dinosaur of a language," even to the point of calling it a crime perpetrated on the students of programming. The fact remains, however, that COBOL is the most widely known and used language in computing. One reason for this is that it does very well what it is supposed to do—and that is to process information in the real world, not teach the niceties of data structures and algorithms in the classroom. Its strengths lie in areas that are the most necessary to business computing: decimal arithmetic and high-level, record-oriented file operations.

More recently, interest in COBOL for the IBM PC family has surged; the microcomputer press is full of announcements and advertisements for new compilers from the software heavyweights. The quantum leap in the processing capacity of desktop hardware now makes it possible to implement useful, large-scale compilers that can do justice to the full capabilities of this programming language. As mainframe jockeys begin to use the equipment they once scorned as mere toys, they are porting to it the language with which they are most familiar, COBOL.



This first installment in a series of reviews of COBOL compilers for the PC will consider Ryan-McFarland COBOL and Realia COBOL. The specific capabilities of these compilers can be appreciated only with a clear understanding of the scope of implementation that is possible in the language.

Because of COBOL's widespread acceptance in the business community, it was one of the first programming languages to be standardized. The American National Standards Institute (ANSI), a nongovernment organization (the same one that produced the ASCII code), developed the first standard in 1968 and revised it in 1974. The ANSI X3.23-1974 COBOL Standard has governed the language ever since. ANSI defined 12 *functional modules* or major features of the language, with two levels of implementation of each. (For a description of the modules and a summary of their capabilities at each level, see "The Twelve Functional Modules of ANS COBOL: How Four Major Compilers Comply," Casey Pontius, *PC Tech Journal*, April 1984, p. 76).

But ANSI has no policing powers, so the standard is purely advisory, and authors of various compilers are free to follow it or disregard it in their implementations as they see fit. Although most follow the standard, the choice of which modules to implement at which level still creates an overwhelming number of possible versions.

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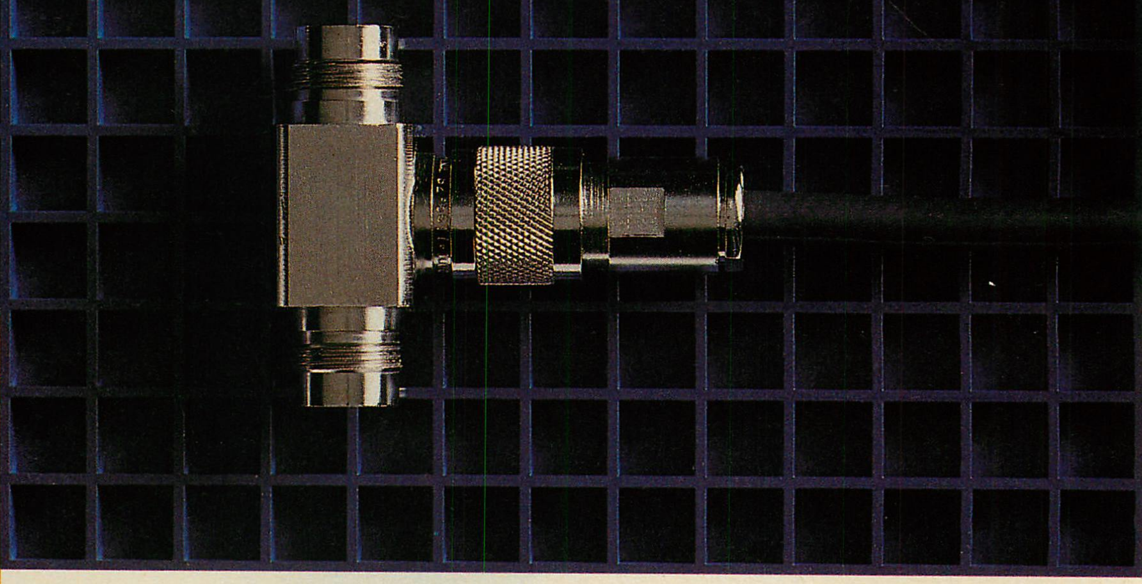

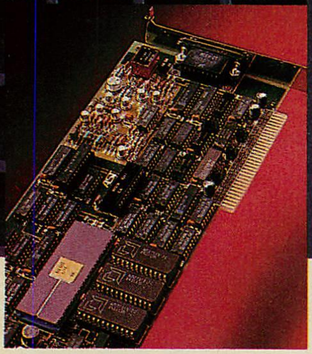

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government agencies that use COBOL, the Department of Commerce issued Federal Information Processing Standards (FIPS) Publication 21-1-1975, which established criteria for COBOL compilers that are acceptable for federal use. The implementations allowed by the standard, from bare bones to super deluxe, are grouped into four levels: low, low-intermediate, high-intermediate, and high. FIPS specifies the modules that must be implemented at each level and the ANSI level for each module. The Federal Compiler Testing Center of the General Service Administration (GSA) tests COBOL compilers for conformance to the appropriate standard level and assigns them to one of the four classification levels.

Thus, there are two dimensions of implementation level: the ANSI level of each of the modules implemented in a compiler, and the federal certification level of the compiler as a whole. In these reviews, reference to levels by number will be to the ANSI level of a functional module; reference by adjective will be to the federal level.

The relationship between the modules, the two ANSI levels, and the four federal levels is shown in table 1. Notice that the steps between successive federal levels are quite large. FIPS stipulates that to attain a certain certification level, a compiler has to meet *all* the criteria for that level. If a compiler misses just one of the requirements, it is classified at a lower level. For example, a compiler lacking the Sort-Merge feature is classified as low-intermediate, even if it implements all other modules at ANSI level 2. As a result, compilers at the same level often exhibit greater differences than those certified at neighboring levels; the Ryan-McFarland and Realia compilers are examples.

One additional preface: COBOL has its own terminology, one that differs somewhat from other languages. For readers primarily experienced in other languages, it might be helpful to explain two terms frequently used in discussing COBOL programs: an *identifier* is the COBOL name for a program variable and a *literal* is a numeric or character (string) constant.

TABLE 1: *Federal Certification Criteria for COBOL Compilers*

	LOW LEVEL	LOW-INTERMEDIATE	HIGH-INTERMEDIATE	HIGH LEVEL
NUCLEUS	1	1	2	2
TABLE HANDLING	1	1	2	2
SEQUENTIAL I/O	1	1	2	2
RELATIVE I/O	–	1	2	2
INDEXED I/O	–	–	–	2
SORT-MERGE	–	–	1	2
REPORT WRITER	–	–	–	–
SEGMENTATION	–	1	1	2
LIBRARY	–	1	1	2
DEBUG	–	1	2	2
INTER-PROGRAM COMMUNICATION	–	1	2	2
COMMUNICATIONS	–	–	2	2

This table describes the relationship between the language's modules, the two ANSI levels, and the four federal levels. The functional modules and their required ANSI implementation levels for each federal certification level are shown.

THE COMPILERS

The first compiler considered in this evaluation is Ryan-McFarland COBOL version 2.0B. RMCOBOL is to COBOL on the IBM PC as dBASE II is to data management. It has been ported to DOS from 8-bit CP/M systems and is available in versions that support a variety of operating systems. This heritage brings with it, however, both good news and bad news.

The bad news is that the compiler shows its age in not taking full advantage of the 16-bit machine: RMCOBOL is limited in memory utilization and lacks some of the more advanced COBOL features. Instead of native machine code, it generates an intermediate code that is interpreted by a runtime system.

The good news is that RMCOBOL is well-known in the marketplace; many applications have been written in it and many potential users of applications already have the runtime system. In addition, a wealth of third-party enhancement products provide utility functions for RMCOBOL source files or data files produced by it. It also may be used as a cross compiler to produce output code for a different machine than the one running the compiler.

RMCOBOL is formally certified by the GSA at the low-intermediate level, but has file I/O functions implemented at ANSI level 2. The package includes several utilities for system configuration, debugging, file maintenance, and customizing the compiler code with patches. The full compiler is $950; the runtime system only is $250.

The second compiler, Realia COBOL version 1.2, although not federally certified, falls into the low-intermediate category because it does not implement Sort-Merge or Communications. However, most of the features it does have are implemented at level 2. It is meant to be a micro version of IBM's mainframe VS COBOL, probably the most widely known and used version of the language in the world. Realia's product will compile most programs downloaded from a mainframe, or it may be used to develop programs for uploading; it produces native machine code in standard DOS object format for linking with the DOS link program. Assembly and C language routines may be linked in. The compiler package, priced at $995, includes a source program editor and source-oriented debugger. With Realia COBOL, there are no licensing fees on runtime applications.

Producers of compiler manuals for languages that are standardized, whether by a de facto standard, such as Kernighan and Ritchie's book for C (*The C Programming Language,* Prentice-Hall, 1978), or by a formal one such as ANSI COBOL, must make assumptions about the expertise of their intended audience. It is probably safe to assume that the majority of users of COBOL on the PC already know the language and therefore do not need a tutorial on programming or formatting and copying disks. For newcomers to the language, the shelves abound with books of that nature. However, since none of these has become a standard in the way the aforementioned text has, none is included with the compilers.

For a user with the sufficient experience or an adequate basic reference book, good compiler documentation consists of two major parts: first, an operating guide that describes installa-

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tion and operation of the compiler, how to run the resulting programs, and how they interact with the operating system; second, a language reference manual that concisely defines the syntax of the language and how it adheres to or departs from the standard.

The Realia documentation fails in this important respect. The manual, an 8½-by-11-inch vinyl three-ring binder, contains a user manual—period. That's right, no language reference. Instead, users are referred to IBM's manual for mainframe VS COBOL, hardly the kind of documentation that is generally found on the shelf of the typical microcomputer user. The neighborhood IBM Product Center does not carry it, and only registered users of said mainframe compiler can buy one from their company's IBM representative. Realia sells this document for an additional $25, but it would seem that a compiler that costs $1,000 should include complete documentation. As an operating guide, the manual is fairly good; the only obvious errors are in the section on the interactive debugger (described shortly). One final blow: no index is included.

By comparison, the RMCOBOL documentation is a model of completeness. The manual is a king-size version of standard IBM PC documentation: the same linen-covered binder in a slip case, measuring 8½ by 11 inches. The book contains an operating guide and a language reference, along with sections on installation, utilities, and configuring the compiler to the user's hardware. The text is typewritten, but easy to read. Only the language reference has an index, even though the user's guide could benefit from one; although it is not long, it is packed full of information with many cross-references.

The language reference is organized according to the structure of the language, not according to the functional modules defined by ANSI, as it is in the VS COBOL and many other COBOL language manuals. It includes chapters on Environment Division, Data Division, and Procedure Division, but none discusses Table Handling or Indexed File I/O. Information about those and the other functional modules is included and treated as subsections in the chapter on Procedure Division. The operational statements of the language are arranged alphabetically within each division, not within each module. Whether this is a good arrangement or not is simply a matter of personal preference, and some users might prefer to have all Environment, Data, and Procedure Statements of one module (for example, Indexed File I/O) to be grouped together. For the most part, the documentation is complete and accurate. Its one problem area, the description of the Segmentation feature, will be discussed later in this review.

LEARNING THE ROPES

A compiler's ease of use depends on its installation procedures, the size of the compiler and associated files, and the procedures required to get through an edit-compile-link-test cycle. Other considerations are compatibility with hardware (fixed disks, RAM disks) and the operating system.

Realia's compiler comes on two double-sided disks. The compiler disk, believe it or not, is copy-protected: no back-ups and no spreading of the compiler's files among floppy disks, RAM disks, or hard-disk subdirectories for the user's convenience. However, the compiler can be installed on a hard disk and run without the original floppy in drive A:. One hard-disk copy is allowed at a time; an uninstall program is provided for moving to a different disk or for clearing the disk for a reinstallation if the copy becomes damaged or is to be moved to a different subdirectory.

The RMCOBOL documentation is a model of completeness; the Realia documentation, however, does not include a language reference.

For floppy disk users, however, the news is all bad. The protection scheme (Superlok) requires several dozen kilobytes of protected files, which increases the chances of taking a hit in an area that cannot be backed up. Even nonrunning back-up copies are not possible, and the first phase of the compiler cannot be loaded to a RAM disk (the other five phases can). As for a hard disk, the installation procedure makes one copy, with the original as the only back-up. That is woefully inadequate for a program that, through its extensive hooks to low-level operating system functions, has the potential to wreak havoc during the debugging process. Score one *very* black mark against Realia's ease of use, (or lack thereof).

On a floppy-disk-based system, the Realia compiler and its overlays take up one (copy-protected) disk; DOS, the link library (103KB), source editor, DOS linker, and miscellaneous utilities take up most of a second. Source files must be relegated to a third. This is quite a bit of disk swapping to get through a test cycle, especially if data files must reside on yet a fourth disk. The user interface is similar to that of the IBM/Microsoft languages, except that the default is to generate the source listing file; the user must specifically request its suppression. Automating the compile and link under a batch file is a cumbersome method because of the multiple disks required. The batch file can be designed to prompt for the link disk at the proper time, but that still requires the user's intervention in order to finish the process.

Two source formats are acceptable to the Realia compiler. Standard ANSI format allows records of no longer than 80 characters, with columns 1 through 6 reserved for the usual (optional) line numbers. Realia format has records of as many as 74 characters in length, with no line numbers, and with column 1 containing the indicator for comments and continuation lines.

The Realia package includes a full-screen editor that is a stand-alone program, not integrated with the compiler or debugger. Primarily intended for editing COBOL programs, it is tailored to the line layout of both ANSI and Realia source formats and can convert between the two. It has a full complement of the usual editing commands and is small (44KB including help screens) and very fast. With a color graphics adapter, it scrolls a full screen almost instantaneously, without generating any video noise—snow—which is quite an accomplishment.

The RMCOBOL compiler comes on three single-sided disks that are not copy-protected. The programs are preconfigured for the IBM PC and DOS and work straight out of the box on a color graphics adapter or monochrome screen. A configuration utility is provided for tailoring to other hardware, and test programs are included for testing all peripherals. The brief installation guide lists the contents of the three disks and specifies which files are required for compiling, running, configuring, and other less frequently performed functions (a helpful detail).

A working compiler system is amazingly small: the compiler, runtime system, a working subset of DOS, and a text editor (not included with the compiler package) take up 180KB to 200KB, leaving plenty of room on a double-

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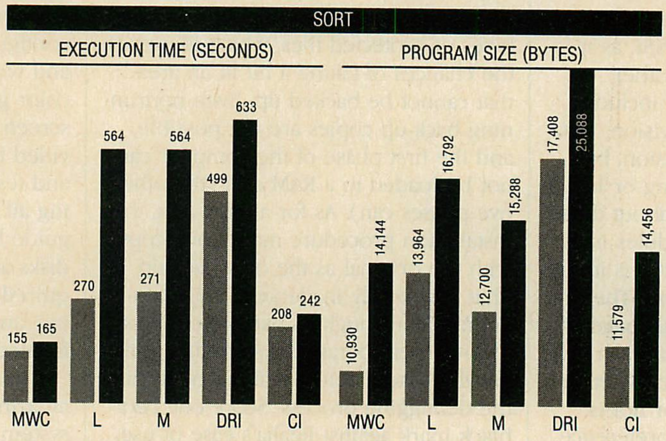

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NOTE: Sort program as in Byte, August 1983, p. 91. Register declaration added. Further information on these benchmarks available from Mark Williams Company upon request.

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sided floppy disk for source program files. This space would be put to good use as the home for copy files that are used by many source programs, or for some of the auxiliary utility programs. Most of the test programs for this review were edited, compiled, and run with no disk swapping whatsoever.

The most obvious measures of compiler performance are speed of compilation and execution and size of generated code. But even more important considerations are an error-free operation and graceful recovery from source code and system errors. Other factors to consider are maximum memory utilization for program and data and the quality of the error messages.

Compilation speed results and sizes of generated code files are shown in table 2 for several programs. The differences between Realia and RMCOBOL are striking and would seem to go against expectations based on the natures of the two compilers.

Realia produces standard object code that is then linked into a .EXE file with the DOS linker; RMCOBOL produces intermediate code that is interpreted by a runtime system without a link step. Realia's two steps were, in every case, faster than RMCOBOL's one, and the larger the source files, the greater the difference. Producing intermediate code for an interpreter should be much quicker than compiling to object code and linking: RMCOBOL's poor showing in compilaton speed suggests its creaking 8-bit heritage. The one advantage of RMCOBOL is the small size of its code files: even though they require 34KB of runtime system in order to execute, only one copy of the runtime is needed for any number of applications on the same disk.

RMCOBOL supports the small memory model, which means 64KB each for program and data. However, the segmentation feature supports program overlays of up to 4KB each. Realia supports the full large memory model, with both program and data space limited only by available memory; Realia also allows overlays.

Error messages for both compilers are adequate. RMCOBOL provides an error number and a cryptic message that usually sends the user flipping through the documentation for a more informative explanation. It does offer the very useful feature of flagging a source line at the point where an error was discovered, and again at the point where the compiler recovered and resumed the scan. Recovery is usually quite graceful, and scan resumption occurs at the first logical opportunity. The syntax of COBOL is such that one error generates many messages, and this clear identification of the scope of the error helps the experienced user in determining which subsequent messages are related to the same error.

Realia's messages are largely self-explanatory; the documentation explains only their general format. That format follows the VS COBOL usage: a severity level indicator, followed by an informative message containing the offending elements from the source line

TABLE 2: *Compiler Performance*

	RMCOBOL	REALIA
ERATOSTHENES SIEVE (80 lines)		
Compile	0:51	0:49
Link	–	0:29
Total	0:51	1:18
Code size	1.5KB[1]	15.0KB
FILE I/O (350 lines)		
Compile	2:34	1:10
Link	–	1:02
Total	2:34	2:12
Code size	3.1KB[1]	25.8KB
MEDIUM-SIZE PROGRAM (500 lines)		
Compile	3:27	1:15
Link	–	0:28
Total	3:27	1:43
Code size	3.6KB[1]	13.4KB
LARGE PROGRAM (1,000 lines)		
Compile	7:05	1:43
Link	–	0:37
Total	7:05	2:20
Code size	6.4KB[1]	21.4KB
GIBSON MIX (1,500 lines)		
Compile	–[2]	2:03
Link		1:07
Total		3:10
Code size		36.7KB

Execution time in minutes:seconds.
[1] For RMCOBOL, code size is for intermediate code; add 34.3KB for the runtime system.
[2] RMCOBOL could not compile the Gibson Mix program because some of the features in the program are not supported by this compiler.

Shown here are the compilation speeds and code size for five benchmark programs of various sizes. Although RMCOBOL produces smaller code files, its compilation speed compares poorly to that of the Realia compiler for large programs.

TABLE 3: *Computational Data Types*

	RMCOBOL	REALIA	MAINFRAME VS COBOL
COMP	Unpacked decimal	User-definable as any other type, including DISPLAY; default is COMP-4	Binary, 2-4 bytes, high byte first
COMP-0	–	–	–
COMP-1	Binary, 16 bits	–	Real, 4 bytes
COMP-2	–	–	Real, 8 bytes
COMP-3	Packed decimal with sign	Packed decimal with sign	Packed decimal with sign
COMP-4	–	Binary, 2-4 bytes, high byte first	Same as COMP
COMP-5	–	Binary, 2-4 bytes, low byte first	–
COMP-6	Unsigned packed decimal	–	–

Although ANSI does not define the internal representation of the various data types, either binary or packed-decimal can be specified for computational data.

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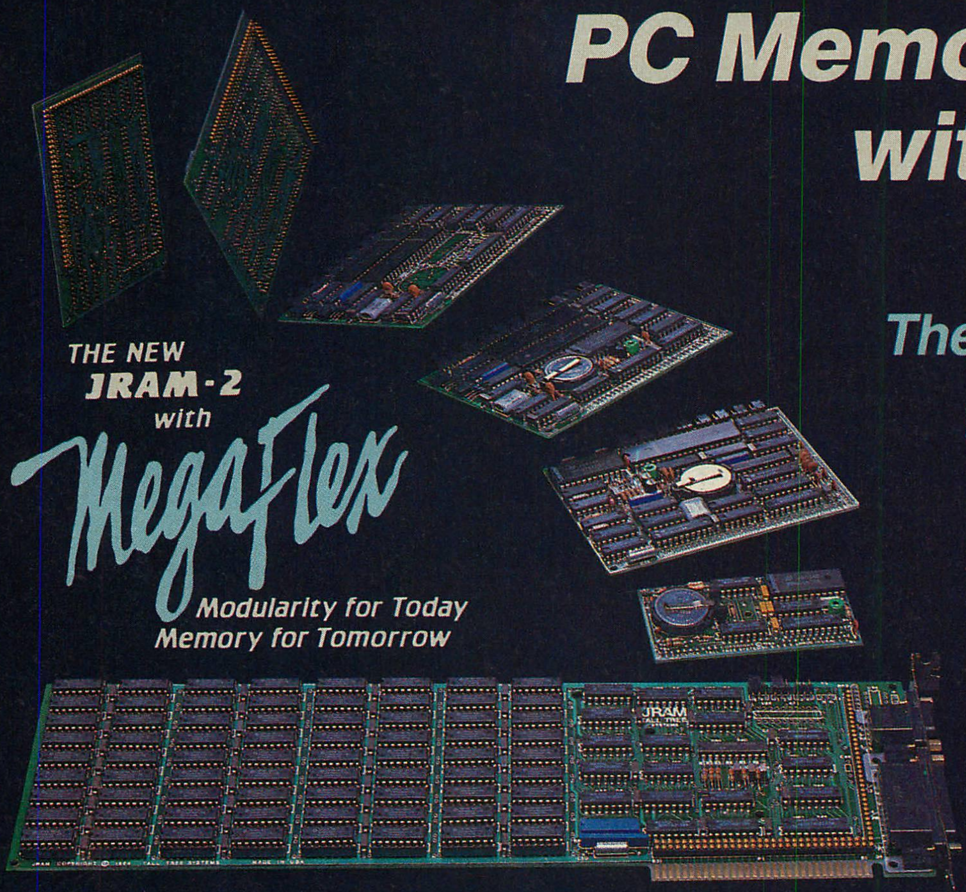

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in error. Mainframe users will feel right at home. Unfortunately, Realia also follows the mainframe practice of not displaying the source line that caused the error: the messages are identified by source line number. This is fine in a batch environment, where a hard-copy source listing is normally produced with each compilation, but not very useful in the interactive micro environment where source listings of long programs are made only rarely.

Both compilers allow full path names wherever a DOS file name may appear, in source programs as well as in compiler commands. In addition, RMCOBOL allows the specification of search paths via DOS SET commands for compiler overlay files and runtime data files; Realia allows search paths only for locating COPY files.

No obvious bugs appeared in the code generated by either compiler. In operation, RMCOBOL is fairly bulletproof, but Realia has a problem with a function that is probably performed more often than any other while compiling: canceling with Ctrl-Break when error messages are being displayed. On several occasions, it either locked the system or wanted to write who-knows-what to the compiler disk (fortunately, it was write-protected). This problem was reported to Realia, but the company had no answers at that time.

An additional consideration is that with all the disk swapping, Realia's compilation and link process is prone to user error. I managed to trash several disks by swapping at the wrong time, but it was never the result of any inherent fault in the compiler other than its unwieldy size for a floppy disk system. Moral: Keep that write-protect tab on the compiler disk.

FUNCTIONAL MODULES

Implementation of the language is the essence of a compiler—just which features of the language standard are implemented and to what extent. For COBOL, conformance to the standard and extensions beyond it are most naturally described in terms of the functional modules defined by ANSI.

Nucleus. The Nucleus defines the Data Division and Procedure Division elements necessary for internal processing: data types, level numbers, qualification, verbs, arithmetic, conditionals, and control structures. Since ANSI level 1 is not a very useful subset, most compilers provide nucleus features at level 2.

Although ANSI does not define the internal representation of the various data types, all compilers permit the specification of either binary or packed decimal for computational data. The use of COMPUTATIONAL-3 for packed decimal is so universal, it has become a standard, but binary types are variously declared as COMP, COMP-0, all the way up to COMP-6. This is one obstacle to source code portability between compilers, albeit a minor one. Table 3 lists

Realia's two steps were, in every case, faster than RMCOBOL's one, and the larger the source files, the greater the difference.

the computational types supported by these two compilers. IBM VS COBOL is included because it is the de facto standard for the language and Realia claims compatibility with it.

Realia's implementation of computational types is the most flexible, allowing the general COMP type to be declared equivalent to any of the others, or even to DISPLAY. Choosing high-low or low-high representation of binary integers is especially useful when data files are to be transferred to or from a program produced by a compiler that does not allow this choice.

RMCOBOL has two unusual computational types: unpacked decimal (COMP) and unsigned packed decimal (COMP-6). Both may be useful, under certain circumstances, but their use reduces the portability of the source code. COMP-1 is a signed 16-bit integer, regardless of the length specified in the PICTURE clause; unsigned and multiword binary numbers are not implemented. Another odd feature of the Data Division is that FILLER items must be elementary, not group items. This is a minor annoyance when writing RMCOBOL programs, but is possibly a bigger problem when porting source written for another compiler.

In the Procedure Division, RMCOBOL is standard and supports many features of level 2. Declarative sections and USE procedures are supported, as is the CORRESPONDING phrase in MOVE, ADD, and SUBTRACT statements. The only major features of the Nucleus that are not implemented are STRING and UNSTRING. A main line program normally does not have access to command line parameters, but an assembly language program may be used to get these and then pass them to the COBOL program.

Realia's Procedure Division is essentially up to the level 2 standard, with some significant extensions. A main program can access command line parameters by means of a USING clause referring to a Linkage Section identifier; in effect, the COBOL main program becomes a subroutine of the operating system. This follows the conventions of IBM's mainframe MVS operating system. More out of the ordinary are extensions that stem from ANSI's new proposed COBOL standard, allowing in-line performed procedures and clauses to terminate conditional statements, such as END IF, END PERFORM, END READ. These constructs permit more highly structured programs, but the result is that the language departs substantially from standard COBOL.

Console I/O. This is not a functional module defined by ANSI, and therein lies one of the weaknesses of COBOL. When the standard was established, COBOL was strictly a noninteractive language, often implemented with punch card input. Interactive processing with video monitors grew too quickly for the standard to keep pace, and now each compiler implements it differently. The standard DISPLAY and ACCEPT verbs are universally used to provide a *glass teletype* similar to the DOS command interface, but the methods used for handling forms-oriented screens are the major causes of incompatibility between different compilers.

The DISPLAY and ACCEPT statements in RMCOBOL allow multiple fields, each with line/column coordinates and specification of video attributes. Thus, an entire screen may be output with one DISPLAY statement and read with one ACCEPT. For DISPLAY, the sending items must have display usage, as no numeric conversions are performed. On input, limited numeric conversion is available to place the input characters into numeric display (but not computational) fields. An ON EXCEPTION phrase allows testing for input not matching the picture, or for special keys. The values returned by the function keys may be set using one of the supplied utility programs.

DISPLAY/ACCEPT combinations may be used in RMCOBOL for forms-oriented, full-screen input, but the full-screen mode is not inherent in the language because there is no easy way to back up to previous fields and no end of screen terminator. The screen input ends when the last field specified in the

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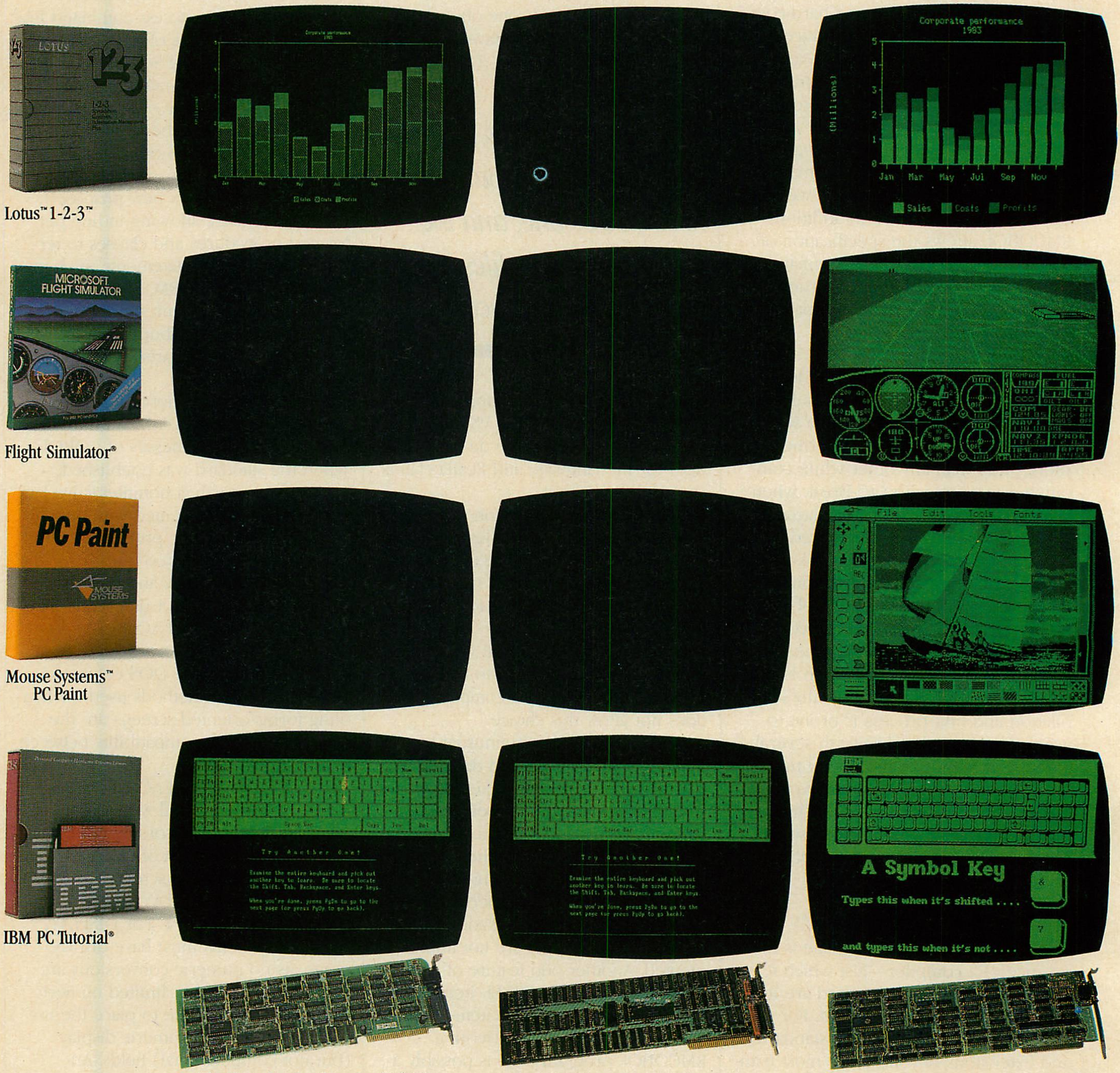

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ACCEPT is filled in. The back-up function, however, may be programmed by appropriate use of ON EXCEPTION.

Realia's DISPLAY statement automatically converts numeric items to display format, but such automatic conversion results in displaying signed numbers with an internal sign on the low-order digit, using EBCDIC conventions. (EBCDIC is the code IBM uses instead of ASCII on its mainframe computers.) The letters A through I represent +1 through +9, and J through R represent −1 through −9. The ACCEPT statement also does automatic conversion of keyboard input into numeric fields, including computational types. Invalid characters in a number are not accepted.

A variety of keys other than Return will terminate input into a field; a predefined register area may then be inspected to determine which terminator was used. The list of terminators and their codes is given in the user's guide. Most of the non-ASCII keys are terminators: function keys, Alt-letter and number combinations, and cursor up and down (but not left and right—more on this later). The codes they return follow the standard PC scan code assignments.

Realia implements screen control with the ANSI.SYS driver, which must be installed at boot time by the presence of a DEVICE=ANSI.SYS statement in the CONFIG.SYS file. The COBOL program can then control cursor placement, changing attributes, blanking all or parts of the screen, and other functions, by displaying values that correspond to the required control sequences. The control codes are listed in the DOS *Technical Reference* manual and repeated in the Realia documentation. In theory, this should provide good compatibility with a variety of systems, or at least those that use the DOS screen management facilities. But this method of screen I/O is slow (see table 4) and degrades Realia's otherwise excellent processing speed.

Unfortunately, neither compiler provides useful editing of a field during ACCEPT; they have no capabilities for insertion or deletion of characters, or for nondestructive cursor motion. The only editing key in RMCOBOL is destructive backspace. In Realia, destructive backspace can be performed by either the backspace or cursor left keys, and the cursor right key restores characters blanked by backspacing. That is why cursor left and right keys cannot be field terminators.

File I/O. File processing is COBOL's strong suit, and because the langauge is not very useful without a full complement of file-handling features, almost all compilers provide some level of support for sequential, relative, and indexed I/O. But the varying syntax of file control statements is one more potential problem when source code is to be ported. Portability of data files between programs produced by various compilers is no better, because each has a file format that may or may not be readable by any other compiler.

RMCOBOL supports full level 2 sequential, relative, and indexed I/O methods. Three kinds of sequential files are supported: binary fixed-length records, binary variable-length with a length word preceding each data record, and line-sequential with variable-length records terminated by the CR/LF sequence. Relative files, which are logically equivalent to BASIC random files, are physically the same as binary sequential files with fixed-length records; the same file may be declared as either sequential or relative.

Indexed files may have up to 14 alternate keys, each of which has the same functionality as the prime key, meaning that either sequential or random access may be performed by any alternate key. For indexed files created by OPEN OUTPUT statements within RMCOBOL programs, the data and keys reside in separate physical files. Data

TABLE 4: *Benchmark Results—Internal Operations*

	RMCOBOL	REALIA
ERATOSTHENES SIEVE, binary		
Per iteration	3:40	3.1 secs.
ERATOSTHENES SIEVE, decimal		
Per iteration	3:47	18.5 secs.
DECIMAL ARITHMETIC		
5,000 iterations	1:10	0:10
CHARACTER OPERATIONS		
500 iterations	3:32	0:10
SCREEN DISPLAY		
10 iterations	0:35	0:36
GIBSON MIX		
Total time, 10,000 iterations	–[1]	5:00
Calculated S-profile		4.5 secs.

Execution time in minutes:seconds except where indicated.
[1] RMCOBOL could not run the Gibson Mix program because some of the features in the program are not supported by this compiler.

The Realia compiler far outpaces RMCOBOL in all tests except screen I/O.

TABLE 5: *Benchmark Results—File Operations*

	100 RECORDS		300 RECORDS	
	RMCOBOL	REALIA	RMCOBOL	REALIA
SEQUENTIAL I/O				
Write	0:05	0:04	0:15	0:08
Read	0:04	0:03	0:13	0:08
Copy	0:19	0:06	0:27	0:15
RELATIVE I/O				
Write[1]	0:05	0:05	0:15	0:14
Read[2]	0:24	0:24	1:06	0:49
Update[3]	0:53	0:54	2:11	2:13
INDEXED I/O				
Write[4]	4:06	0:17	6:26	2:59
Read[5]	0:48	0:12	2:14	1:16
Update[6]	4:27	0:24	9:34	3:52

Execution times in minutes:seconds.
[1] Write in sequence by record number.
[2] Read nonconsecutive record numbers.
[3] Read nonconsecutive record numbers, rewrite each.
[4] Write with primary keys not in sequence. One alternate key.
[5] Read in different order than written.
[6] Read in different order than written, change alternate key.

All files have fixed records of 100 bytes. Realia is especially fast in indexed I/O.

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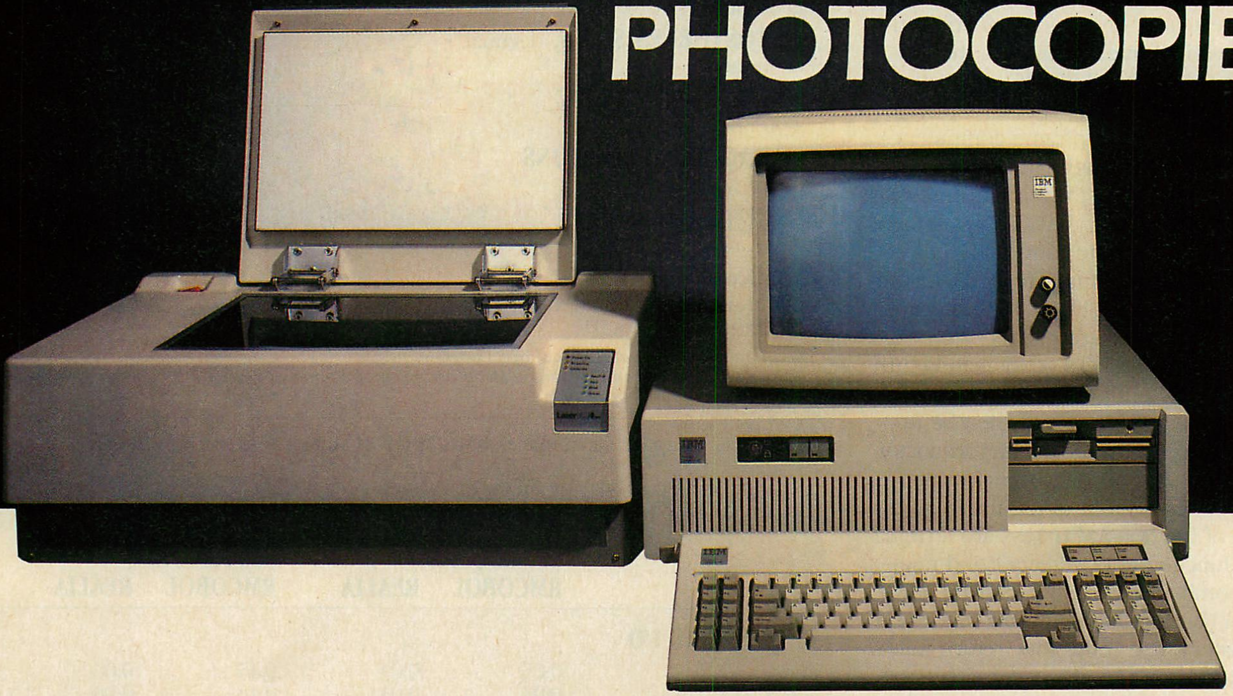

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and indexes can reside in one file if indexed file space is preallocated with one of the utility programs. In the two-file format, the data portion has the same format as a binary sequential file with fixed-length records. This provides a means of recovering files with damaged indexes: reading the data portion as a sequential file and writing the records to an indexed file will rebuild the indexes. RMCOBOL documentation describes the formats of all file types except the index structure. A facility for file and record locking on multiuser systems is provided.

The Realia file system has nine file formats: four sequential, four either sequential or relative, and one indexed. Line-sequential files are supported, but are not described by the phrase ORGANIZATION LINE SEQUENTIAL, which has become virtually a standard for micro COBOL. All formats except indexed are adequately documented, but the file headers make it difficult to read these files with other COBOLs that cannot read variable-length records without a preceding length word (Realia can, as byte stream files).

Realia indexed files also allow up to 14 alternate keys, and random I/O may be performed by either prime or alternate keys. Realia keeps indexes and data in one physical file, but a file with a damaged index structure is recoverable as long as the data record chain is intact. A file is rebuilt by being read as ORGANIZATION INDEXED, ACCESS SEQUENTIAL, and written to another file as ORGANIZATION INDEXED, ACCESS RANDOM (or DYNAMIC). As shown by the benchmark times in table 5, performance on indexed I/O is very good; obviously, large buffers are being used to keep index structures in memory as long as possible.

In both compilers, program file names are identified with physical files in the ASSIGN clause of a SELECT statement; the assignment may be either static (hard-coded in the source) or dynamic (assigned to an identifier that will contain a file name at open time). Realia has an additional assignment mechanism, arising from its compatibility with VS COBOL: the assignment is made to a name that is equated to a file name in a DOS SET command. Fans and victims of MVS will recognize this procedure as the equivalent of the DD statement of that operating system's JCL (Job Control Language).

In all assignment methods, files in directories other than the current one may be identified by path names. RMCOBOL will search for files on one or more paths specified at the DOS level in a SET command; for Realia, the location of data files in the directory structure must be explicitly specified.

Table Handling. This module allows the definition and processing of tables of up to three dimensions. Two methods of identifying an element of a table are provided in the language: a subscript (which may be an identifier or numeric literal) is the occurrence number of the element in the table; an index (always an identifier) is the byte offset of the start of an element from the beginning of the table. Subscripts are manipulated by normal data movement and arithmetic statements; indexes are manipulated by SET statements. The Eratosthenes Sieve benchmark is a good indication of table handling efficiency.

RMCOBOL supports full level 2 sequential, relative, and indexed I/O methods.

Realia implements full level 2, meaning it allows variable-length tables (OCCURS DEPENDING ON), ascending or descending keys, and automatic sequential or binary searching (SEARCH, SEARCH ALL). Indexing instead of subscripting provides a moderate speed increase. Using SEARCH instead of programmed loops can improve the efficiency of table lookups.

RMCOBOL's table handling is essentially at level 1 (except that variable-length tables are supported), with virtually no performance difference between subscripting and indexing.

Library. The Library module implements the COPY verb, which allows the inclusion of source code from another file in a compilation. Level 1 allows copying from one library (directory, in DOS) with no modification to the copied text; Level 2 allows copying from multiple libraries and macro-style text replacement. RMCOBOL supports level 1, but multiple paths may be searched to find a copy file. Realia implements most of level 2 except pseudotext replacement (only whole words may be replaced, not strings with blanks and other delimiters), and will also search paths for the copy files.

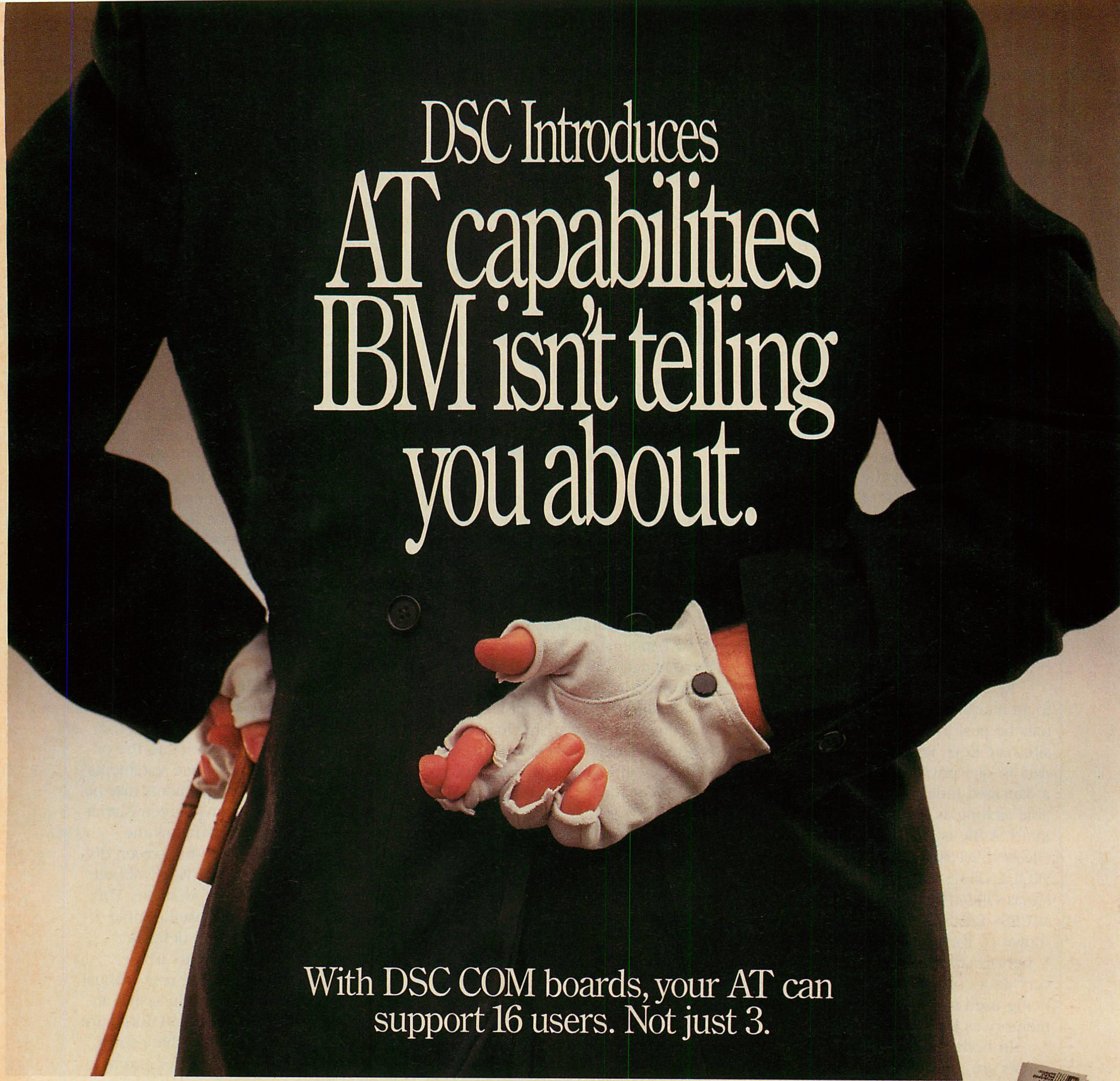
Debug. The standard Debug module, like Console I/O, is a carry-over from batch processing days and not very useful in the micro environment. Nevertheless, RMCOBOL provides standard level 1 debugging facilities that allow marking source lines as debugging lines, to be compiled only if a compile-time switch is set. If the switch is not set, these lines are treated as comments. This switch must be set on the compiler command line, and not by the clause WITH DEBUGGING MODE within the source program. USE FOR DEBUGGING sections are not supported.

In addition, RMCOBOL provides an interactive debugger. It is not a symbolic debugger, and it refers to addresses, not data names and labels in the program, so a source listing with an address map is required for reference. In operation, it is very similar to the IBM DEBUG program, but tailored to COBOL and the structure of the RM runtime system. Single-stepping is by statement, not by machine instruction, and data display can be in a variety of formats, not only hexadecimal. However, the format must be specified for each display command; the picture and usage declared in the source program are not available to the debugger.

Realia provides no support for any standard debugging features. Instead, its interactive symbolic debugger displays source code while a program is running. Breakpoints may be set and data values displayed by pointing to the on-screen source listing; single statements or marked blocks of statements may be executed. The program's screen output may scroll in a window below the source display, alternate full-screen displays with the source, or be displayed on a second monitor, if available. This is quite an elegant and useful implementation of a high-level debugger.

One minor flaw occurs in the Realia documentation. The user manual has several errors, but nothing that an experienced DOS user could not figure out. Basically, the order of file names and switches in the debugger's command line is reversed, and the debugger is not always able to find the program if the .EXE extension is omitted.

Inter-Program Communication. This module allows the calling of separately compiled subprograms written in COBOL or another language. In the level 1 implementation, all calls are static: the subprogram names must be known at compile time and coded into the source as literals. All such subprograms are loaded into memory once, together with the main program, typically by inclusion into one load module at link time. Level 2 allows the user to call subprograms, the names of which are not known until runtime; such subprograms are dynamically loaded as



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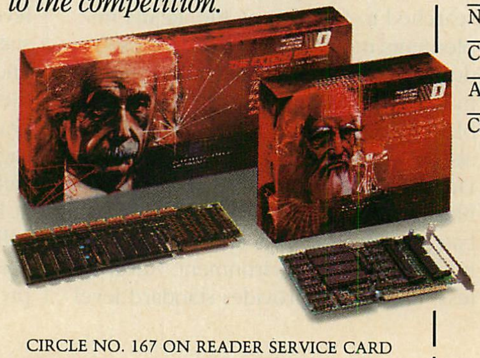

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needed. Memory management functions are provided to determine the availability of memory and to remove unneeded programs from memory. Both compilers support level 2 of the CALL statement for COBOL subprograms, and somewhat less than that for assembly language routines.

Because RMCOBOL has no link step, it cannot build several separately compiled COBOL programs into one load module, but must load each subprogram as it is called, even those with names that are hard-coded in the source. However, assembly language routines may be statically loaded by linking them into the runtime system with a utility program. Other options are available for hooking assembly language routines to the runtime system, and some of them require patching the runtime with yet another utility. One option allows the routine to run before the COBOL program gets control; this may be used to pass command-line parameters into the COBOL program.

Two callable routines are provided with RMCOBOL. The first controls video attributes; it is provided in source form to serve as an example of interfacing to assembly language. The second returns various system-specific information that permits programs to be portable across operating systems.

Realia allows COBOL, assembly language, or C subprograms to be linked in with the main program; only COBOL subprograms may be loaded at runtime. If the user desires, all subprogram calls may be made dynamically through the use of a compile-time switch, provided that only COBOL routines are called. Realia's interface to assembly language routines is straightforward and well documented, although the calling sequence is odd: the first two parameter addresses are passed in registers, the subsequent ones on the stack.

The interface to C supports the Lattice version of that language; it is somewhat complicated but well explained in the manual. The C routines must be compiled for the large memory model.

The Realia object library includes callable routines that perform low-level DOS function calls: more than half of the INT 21H functions, INT 25H, and INT 26H (disk I/O by absolute sector).

Segmentation. With microcomputer memory as inexpensive as it is, program overlays are not as important as they were in the days of the 64KB machine, provided that a program can use all of the hardware's capabilities. Still, the memory usage of a large program may need to be limited to allow its running on small systems, or on those with large RAM disks.

In COBOL, overlays are created at the source language level by dividing the Procedure Division into numbered sections, some of which are permanently resident (fixed) while others are overlayable (independent). Level 1 of

Realia implements segmentation at level 2, with a useful extension: a PERFORM statement in one independent segment may have its range in another independent segment.

the Segmentation module requires that all code in each section number be physically contiguous in the source, and that the section numbers occur in numeric sequence. Level 2 allows randomly ordered and noncontiguous sections, so that sequential execution can enter a new overlay and then return to the first. Fixed sections may be logically, but not physically, permanent: they may be overlayed and then restored in their last-used state.

RMCOBOL provides level 1 support of segmentation, even though the documentation does not make this clear. The rules on ordering sections are explicitly stated only in the explanations of the error messages that result from disregarding them. Segment numbers up to 127 are allowed, in comparison to the 99 allowed by the standard.

Realia implements segmentation at level 2 with a useful extension: a PERFORM statement in one independent segment may have its range in another. The standard requires that the range be in the same or a fixed segment. The DOS 2.1 link program easily generates the overlays.

DIFFERENT STROKES

Despite COBOL's supposed standardization, getting a source program to run on more than one compiler is no easy feat. Besides the obvious differences as to which modules are or are not implemented, even standard features such as file control, copy statements, and the declaration of the various computational data types are expressed differently for each compiler. Since benchmarks are at best an artificial test of compiler performance, it was decided to run programs that are as similar as possible, rather than programs that are optimized to each compiler's features. The test results therefore compare the execution of nearly identical code, rather than the best-case execution.

Because of compiler differences, it was impractical to find a useful, long program that would serve as a meaningful test of compilation speed for both compilers. Instead, sections of a trivial program (listing 1, the decimal arithmetic and string-handling benchmark) were replicated several times to build up files of 500 and 1,000 lines.

For execution speed testing of COBOL programs, the most widely used benchmark is the Gibson Mix program, developed by IBM in the 1960s to test hardware performance when running COBOL. But it is also used to compare various compilers on the same hardware. The program performs a variety of computational and control functions and calculates an *S-profile* that weights the various functions according to their estimated importance in the mythical typical production program.

The test was run with 10,000 iterations, but the S-profile, a measure of rate of execution, is independent of the number of iterations. A low number produces inconsistent results because the speed of some of the elementary operations approaches the resolution of the system timer; 10,000 iterations is the lower limit that produces consistent results. The execution time, of course, varies with the number of iterations.

Unfortunately, the Gibson program (provided by MBP COBOL, to be reviewed in a subsequent article) would not compile with RMCOBOL; it does not support all of the features tested. The results are given for Realia to permit comparison with the other compilers that will be tested later in this series. At 1,500 lines of source code, this program is too long to reproduce here but will be available through *PC Tech Journal*'s Listing Diskette Service.

The Eratosthenes Sieve benchmark (listing 2), although not especially meaningful for COBOL, is provided for comparison with other languages. The standard Sieve benchmark counts all the primes in the range 3 to 16,383. Two versions were tested, using binary and decimal arithmetic respectively. The program shown in listing 2 is essentially the same as the one published in *BYTE* ("Eratosthenes Revisited," Jim Gilbreath and Gary Gilbreath, January 1983, p.

Realia COBOL

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2. Wait some more.
3. Stop waiting. Call Realia.

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Compilation Speed (minutes:seconds)

Lines in Program	Realia COBOL	mbp COBOL	Level II COBOL	R-M COBOL	Microsoft COBOL
1,000	:51	8:33	3:42	5:05	5:11
5,000	3:30	48:07	16:58	*	45:26

*Could not successfully compile the program.

Execution Time Ratio
(Gibson Mix; calculated S-Profile)

Realia COBOL	mbp COBOL	Level II COBOL	R-M COBOL	Microsoft COBOL
1.0	3.6	14.7	21.6	22.3

Sieve of Eratosthenes

0.818 seconds per iteration

All benchmark tests were performed on an IBM PC-XT with 192KB of memory. IBM PC-XT is a registered trademark of International Business Machines Corporation; mbp COBOL, of mbp Software and System Technology; Level II COBOL, of Micro Focus; R-M COBOL, of Ryan-McFarland; and Microsoft COBOL, of Microsoft.

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283), but modified to allow a variable number of iterations and to calculate elapsed time. It is not the most efficient way to code this test, and Realia provides another version that runs much faster, but the version used here is a widely available standard.

The Pentathlon program, used as a benchmark for compilers for other languages in previous reviews in *PC Tech Journal*, is not really applicable to COBOL. Features tested by that program are either not implemented in COBOL (floating-point arithmetic) or are usually coded at a higher level than the byte-by-byte methods of C or Pascal. Instead, trial programs were developed that would specifically test those operations for which COBOL is most often used: decimal arithmetic, screen output, string operations, and especially, record-oriented file I/O.

The file I/O tests (listing 3) exercise several features of sequential, relative, and indexed access methods. The record length of each file is 100 bytes; results are given for total file lengths of 100 and 300 records to indicate how I/O time increases with file size. Relative and indexed records were read and updated in a different order than they were written. For indexed files, the record keys were written in nonconsecutive order, and updated by changing the alternate key to produce activity in both the data and index portions of the file. Each file test was started with a blank formatted data disk to minimize differences that might be caused by disk space considerations. The number of buffers was left at the DOS default of two; indexed file performance increases with more buffers.

All tests were run under DOS 2.1 on an IBM PC-2 with 640KB of memory and two double-sided floppy drives. Timings were taken according to the system timer, and sufficient iterations were performed to produce elapsed times of at least several seconds. This minimized the inaccuracies possible with the PC's timer, which has a resolution of 55 milliseconds. Compilation and link times include the loading of the compiler or linker from floppy disk and generating output files on floppies; they represent worst-case times that could be improved by running from and to a RAM drive or hard disk. When a disk swap was required, the swap time was excluded from the results; execution times were calculated within the program and exclude load time.

Execution benchmark results for internal operations are shown in table 4. Here again, Realia is the overwhelming winner in everything but screen display (see listing 4). This compiler's code is blazingly fast, not only in comparison to RMCOBOL, but to other native code compilers that are currently in preliminary testing for subsequent installments in this series.

The Realia compiler's code is blazingly fast, not only in comparison to RMCOBOL, but also to other native code compilers. Its speed was exceptional in every area except screen display.

Some comments on the Sieve benchmark results: Realia has been advertising a much better time for the Sieve, and provides a program that does in fact run as fast as advertised. However, it utilizes a higher level implementation of table handling and, moreover, is written with nonstandard language extensions that provide added efficiency. Still, the results using the standard Sieve test are nothing to be ashamed of. RMCOBOL shows little difference between decimal and binary versions; since binary arithmetic is inherently faster, this indicates that the runtime system spends more time interpreting than executing the code.

File I/O benchmark results are tabulated in table 5. Here, the mechanics of disk access outweigh the efficiency of native over interpreted code, but Realia still manages to come out ahead in all tests except relative I/O, which is about a draw. The most significant differences are in indexed file performance, because building and updating the index structures are basically internal operations, where Realia code just screams.

The conclusions reached here were formed entirely from the review process, lasting only a few weeks. For the long term, or for specialized applications, minor quirks may turn into major shortcomings, and features that at first seem desirable may turn out to be useless bells and whistles.

Realia is a big, capable compiler, faster than any other COBOL I have seen to date. Even though it falls short of the holy grail of high-level certification, it provides everything needed for serious applications development in the interactive environment of the microcomputer: large program and data size, excellent compilation and execution speed, comprehensive file capabilities, a symbolic debugger, source editor, and DOS compatibility. Its unofficial classification as low-intermediate is more an indication of how outdated the federal classifications are rather than a reflection on its capabilities.

There are, however, several flies in the ointment. One is minor, fixable by the application of additional cash to buy the language reference manual. The bug in the Ctrl-Break response also could be more serious if it is not fixed. Another disadvantage is the large size of the system, requiring a hard disk for practical operation. The last problem is the most serious: copy protection. This reduces the usefulness of any program, but a compiler more than any other. If it were not copy-protected and if the bug were to be fixed, Realia could come highly recommended.

Ryan-McFarland COBOL is somewhat out of its league in this comparison. It is a capable performer, with a large installed base of applications. At half the price, it would be an easy-to-use, entry-level compiler for learning the COBOL ropes. But considering its cost and runtime licensing fees, it seems overpriced in comparison to its capabilities. I can recommend it only for cases that require compatibility with existing RMCOBOL applications.

A final, updated look at the Realia and Ryan-McFarland COBOL compilers, with overall recommendations and ratings in comparison with the other compilers to be reviewed, will be presented at the end of this series.

Realia COBOL: $995
Realia, Inc.
10 South Riverside Plaza
Chicago, IL 60606
312/346-0642
CIRCLE 355 ON READER SERVICE CARD

RMCOBOL: $950; runtime system only, $250
Ryan-McFarland
609 Deep Valley Drive
Rolling Hills Estates, CA 90274
213/541-4828
CIRCLE 354 ON READER SERVICE CARD

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LISTING 1: ARITH.COB

```
 IDENTIFICATION DIVISION.
PROGRAM-ID.     ARITH.

*       ARITHMETIC & CHARACTER BENCHMARK
*       FOR BOTH REALIA & RMCOBOL, W/NO CHANGES

 ENVIRONMENT DIVISION.
 CONFIGURATION SECTION.
 SOURCE-COMPUTER.  IBM-PC.
 OBJECT-COMPUTER.  IBM-PC.

 DATA DIVISION.
 WORKING-STORAGE SECTION.
 77  A-MAX                  PIC 99999  VALUE 5000.
 77  C-MAX                  PIC 99999  VALUE 500.
 77  N                      PIC 99999.
 77  N-S                    PIC 99.
 77  N-SUM                  PIC 99999.
 77  PRODUCT                PIC 99999.
 77  TWO                    PIC 99     VALUE 2.
 77  THREE                  PIC 99     VALUE 3.
 77  HALF                   PIC 99999V9.
 77  ARITH-MSG     PIC X(20) VALUE "DECIMAL ARITHMETIC  ".
 77  CHAR-MSG      PIC X(20) VALUE "CHARACTER OPERATIONS".

 01  ARRAY-1.
     05  ARRAY-2.
         10  STRING-1         PIC X(10) VALUE "1234567890".
         10  STRING-2         PIC X(10) OCCURS 9 TIMES.
     05  ARRAY-3              REDEFINES ARRAY-2.
         10  WORD             PIC XX     OCCURS 50 TIMES.

* COPY TIMERDAT for Realia, COPY "TIMERDAT.CBL" for RMC
     COPY TIMERDAT.

 PROCEDURE DIVISION.
 000-MAINLINE.
     PERFORM 200-ARITH-TEST THRU 200-EXIT.
     PERFORM 300-CHAR-TEST  THRU 300-EXIT.
     STOP RUN.


 200-ARITH-TEST.
     DISPLAY " ".
     DISPLAY ARITH-MSG.
     ACCEPT TIMER-START FROM TIME.
     PERFORM 220-ARITH-LOOP THRU 220-EXIT
       VARYING N FROM 1 BY 1 UNTIL N > A-MAX.
     ACCEPT TIMER-END FROM TIME.
     PERFORM 2400-CALC-TIME THRU 2400-EXIT.
     DISPLAY ELAPSED-TIME.
 200-EXIT.    EXIT.

 220-ARITH-LOOP.
     MULTIPLY N BY THREE GIVING PRODUCT.
     ADD N, PRODUCT GIVING N-SUM.
     DIVIDE N BY TWO GIVING HALF.
 220-EXIT.    EXIT.

 300-CHAR-TEST.
     DISPLAY CHAR-MSG.
     ACCEPT TIMER-START FROM TIME.
     PERFORM 320-CHAR-LOOP THRU 320-EXIT C-MAX TIMES.
     ACCEPT TIMER-END FROM TIME.
     PERFORM 2400-CALC-TIME THRU 2400-EXIT.
     DISPLAY ELAPSED-TIME.
 300-EXIT.   EXIT.

 320-CHAR-LOOP.
     MOVE STRING-1 TO STRING-2 (1).
     PERFORM 330-CHAR-MOVE THRU 330-EXIT
        VARYING N FROM 2 BY 1 UNTIL N > 9.
     PERFORM 340-CHAR-COMP THRU 340-EXIT
        VARYING N FROM 1 BY 1 UNTIL N > 50.
 320-EXIT.    EXIT.

 330-CHAR-MOVE.
     SUBTRACT 1 FROM N GIVING N-S.
     MOVE STRING-2 (N-S) TO STRING-2 (N).
 330-EXIT.    EXIT.

 340-CHAR-COMP.
     IF WORD (N) = "56" ADD 1 TO N-SUM.
 340-EXIT.    EXIT.

* COPY TIMERPRO for Realia, COPY "TIMERPRO.CBL" for RMC
     COPY TIMERPRO.
```

LISTING 2: SIEVE.COB

```
 IDENTIFICATION DIVISION.
*
*    SIEVE OF ERATOSTHENES
*    BYTE MAGAZINE HIGH-LEVEL LANGUAGE BENCHMARK
*    JANUARY 1983 BYTE, PAGE 283
*
 PROGRAM-ID. SIEVE.
 ENVIRONMENT DIVISION.
 CONFIGURATION SECTION.
 SOURCE-COMPUTER.         IBM-PC.
 OBJECT-COMPUTER.         IBM-PC.
*
 DATA DIVISION.
 WORKING-STORAGE SECTION.

* FOR DECIMAL VERSION, USAGE IS COMP-3.
* FOR BINARY, USAGE COMP-1 FOR RMCOBOL, COMP-4 FOR REALIA.

 01  MISC.
     05  I             PIC 9(4) COMP-3.
     05  K             PIC 9(5) COMP-3.
     05  PRIME-COUNT   PIC 9(4) COMP-3.
     05  PRIME         PIC 9(5) COMP-3.
     05  INPUT-COUNT   PIC 99999.
     05  ITER-COUNT    PIC 9(4) COMP-3.
     05  PRIME-DISP    PIC 9(4).
*
 01  FLAG-AREA.
     05  FLAGS         PIC X OCCURS 8191 TIMES.
*
* COPY TIMERDAT for Realia, COPY "TIMERDAT.CBL" for RMC
     COPY TIMERDAT.
*
*
 PROCEDURE DIVISION.
 DISPLAY-MESSAGE.
     DISPLAY "Sieve of Eratosthenes prime number routine.".
     DISPLAY " ".
     PERFORM 100-GET-COUNT THRU 100-EXIT
       UNTIL INPUT-COUNT NUMERIC.
     MOVE INPUT-COUNT TO ITER-COUNT.
*
 TESTING-MODULE.
     ACCEPT TIMER-START FROM TIME.
     PERFORM ITERATION-ROUTINE ITER-COUNT TIMES.
     ACCEPT TIMER-END FROM TIME.
     PERFORM 2400-CALC-TIME THRU 2400-EXIT.
     DISPLAY ELAPSED-TIME.
     STOP RUN.
*
 ITERATION-ROUTINE.
     MOVE ZERO TO PRIME-COUNT.
     PERFORM TABLE-FILL-ROUTINE VARYING I FROM 1 BY 1
           UNTIL I = 8191.
     PERFORM COMPARE-ROUTINE THRU COMPARE-EXIT VARYING I
           FROM 1 BY 1 UNTIL I = 8191.
*
 TABLE-FILL-ROUTINE.
     MOVE "1" TO FLAGS (I).
*
 COMPARE-ROUTINE.
     IF FLAGS (I) = "0" GO TO COMPARE-EXIT.
     COMPUTE PRIME = I + I + 1.
     COMPUTE K = I + PRIME.
     PERFORM STRIKOUT UNTIL K > 8191.
     ADD 1 TO PRIME-COUNT.
*
```

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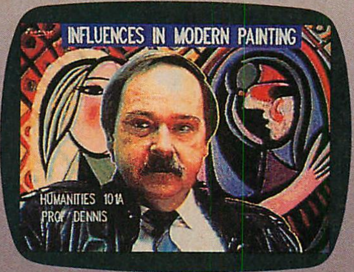

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```
COMPARE-EXIT.
    EXIT.
*
STRIKOUT.
    MOVE "0" TO FLAGS (K).
    ADD PRIME TO K.
*

100-GET-COUNT.
    DISPLAY "Enter iteration count 1-100".
    ACCEPT INPUT-COUNT.
100-EXIT.   EXIT.

* COPY TIMERPRO for Realia, COPY "TIMERPRO.CBL" for RMC
    COPY TIMERPRO.
```

LISTING 3: FILEIO.COB

```
IDENTIFICATION DIVISION.
PROGRAM-ID.     FILEIO.
*       FILE I-O BENCHMARK

ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER.  IBM-PC.
OBJECT-COMPUTER.  IBM-PC.
*
INPUT-OUTPUT SECTION.
FILE-CONTROL.

* THESE SELECT STATEMENTS ARE FOR RMCOBOL

*    SELECT SEQ-FILE1
*           ASSIGN TO INPUT-OUTPUT, "B:FILE1.SEQ"
*           ORGANIZATION BINARY SEQUENTIAL.
*    SELECT SEQ-FILE2
*           ASSIGN TO OUTPUT,       "B:FILE2.SEQ"
*           ORGANIZATION BINARY SEQUENTIAL.
*    SELECT REL-FILE3
*           ASSIGN TO RANDOM, "B:FILE3.REL"
*           ORGANIZATION RELATIVE
*           ACCESS DYNAMIC
*           RELATIVE KEY REC-NUM
*           FILE STATUS IO-STAT.
*    SELECT INX-FILE4
*           ASSIGN TO RANDOM, "B:FILE4.DAT"
*           ORGANIZATION INDEXED
*           ACCESS DYNAMIC
*           RECORD KEY REC-KEY
*           ALTERNATE RECORD KEY ALT-KEY WITH DUPLICATES
*           FILE STATUS IO-STAT.

* THESE SELECT STATEMENTS ARE FOR REALIA COBOL

    SELECT SEQ-FILE1
           ASSIGN TO  "B:FILE1.SEQ[F]"
           ORGANIZATION SEQUENTIAL.

    SELECT SEQ-FILE2
           ASSIGN TO  "B:FILE2.SEQ[F]"
           ORGANIZATION SEQUENTIAL.

    SELECT REL-FILE3
           ASSIGN TO  "B:FILE3.REL[F]"
           ORGANIZATION RELATIVE
           ACCESS DYNAMIC
           RELATIVE KEY REC-NUM
           FILE STATUS IO-STAT.

    SELECT INX-FILE4
           ASSIGN TO  "B:FILE4.DAT"
           ORGANIZATION INDEXED
           ACCESS DYNAMIC
           RECORD KEY REC-KEY
           ALTERNATE RECORD KEY ALT-KEY WITH DUPLICATES
           FILE STATUS IO-STAT.

DATA DIVISION.
FILE SECTION.
FD  SEQ-FILE1 LABEL RECORDS ARE STANDARD.
01  RECORD-1.
    05  SEQ-REC-WORD              PIC X(7).
    05  SEQ-REC-NUM               PIC 9999.
    05  SEQ-REC-TAIL              PIC X(89).
FD  SEQ-FILE2 LABEL RECORDS ARE STANDARD.
01  RECORD-2                      PIC X(100).
FD  REL-FILE3 LABEL RECORDS ARE STANDARD.
01  RECORD-3.
    05  REL-REC-WORD              PIC X(7).
    05  REL-REC-NUM               PIC 9999.
    05  REL-REC-TAIL              PIC X(89).
FD  INX-FILE4 LABEL RECORDS ARE STANDARD.
01  RECORD-4.
    05  INX-REC-WORD              PIC X(7).
    05  REC-KEY                   PIC XXXX.
    05  ALT-WORD                  PIC X(5).
    05  ALT-KEY                   PIC XXXX.
    05  INX-REC-TAIL              PIC X(80).

WORKING-STORAGE SECTION.
77  REC-LIMIT                     PIC S999 COMP-3
                                      VALUE 300.
77  REC-COUNT                     PIC S999 COMP-3.
77  REC-NUM                       PIC S999 COMP-3.
77  HALF-WAY                      PIC S999 COMP-3.
77  COUNTER                       PIC S999 COMP-3.

01  IO-ERR-MSG.
    05  FILLER         PIC X(16) VALUE "IO-ERROR STATUS ".
    05  IO-STAT                   PIC XX.
01  FILE-MSG.
    05  FILE-TYPE                 PIC X(11).
    05  IO-TYPE                   PIC X(6).
    05  MAX-RECS                  PIC ZZZ9.
    05  FILLER   PIC X(8)    VALUE " RECORDS".

* COPY TIMERDAT for RM, COPY "TIMERDAT.CBL" for Realia.
    COPY TIMERDAT.

PROCEDURE DIVISION.
DECLARATIVES.
IO-ERROR SECTION.
    USE AFTER STANDARD ERROR PROCEDURE ON REL-FILE3,
                                          INX-FILE4.
REL-IO-ERROR.
    DISPLAY " ".
    DISPLAY " ".
    DISPLAY " ".
    DISPLAY " ".
    DISPLAY " ".
    DISPLAY " ".
    DISPLAY IO-ERR-MSG.
    STOP RUN.
END DECLARATIVES.
MAINLINE SECTION.
000-MAINLINE.
    DISPLAY " ".
    DISPLAY " ".
    DISPLAY " ".
    DISPLAY " ".
    DISPLAY " ".
    DISPLAY " ".
    DISPLAY " ".
    PERFORM 100-SEQ-FILE-I-O    THRU 100-EXIT.
    PERFORM 200-SEQ-FILE-COPY   THRU 200-EXIT.
    PERFORM 300-REL-FILE-I-O    THRU 300-EXIT.
    PERFORM 400-INX-FILE-WRITE THRU 400-EXIT.
    PERFORM 500-INX-FILE-READ   THRU 500-EXIT.
    PERFORM 600-INX-FILE-IO     THRU 600-EXIT.
    STOP RUN.

100-SEQ-FILE-I-O.
    MOVE "SEQUENTIAL " TO FILE-TYPE.
    MOVE REC-LIMIT TO MAX-RECS.
    MOVE "WRITE "  TO IO-TYPE.
    DISPLAY FILE-MSG.
    ACCEPT TIMER-START FROM TIME.
    OPEN OUTPUT SEQ-FILE1.
    PERFORM 120-SEQ-LOOP THRU 120-EXIT
```

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```
        VARYING REC-COUNT FROM 1 BY 1
        UNTIL REC-COUNT > REC-LIMIT.
     CLOSE SEQ-FILE1.
     ACCEPT TIMER-END FROM TIME.
     PERFORM 2400-CALC-TIME THRU 2400-EXIT.
     DISPLAY ELAPSED-TIME.

     MOVE "READ " TO IO-TYPE.
     DISPLAY FILE-MSG.
     ACCEPT TIMER-START FROM TIME.
     OPEN INPUT SEQ-FILE1.
     PERFORM 130-SEQ-LOOP THRU 130-EXIT
        VARYING REC-COUNT FROM 1 BY 1
        UNTIL REC-COUNT > REC-LIMIT.
     CLOSE SEQ-FILE1.
     ACCEPT TIMER-END FROM TIME.
     PERFORM 2400-CALC-TIME THRU 2400-EXIT.
     DISPLAY ELAPSED-TIME.
 100-EXIT.    EXIT.

 120-SEQ-LOOP.
     MOVE "RECORD"  TO SEQ-REC-WORD.
     MOVE REC-COUNT TO SEQ-REC-NUM.
     MOVE SPACES    TO SEQ-REC-TAIL.
     WRITE RECORD-1.
 120-EXIT.    EXIT.

 130-SEQ-LOOP.
     READ SEQ-FILE1.
 130-EXIT.    EXIT.

 200-SEQ-FILE-COPY.
     MOVE "COPY  "  TO IO-TYPE.
     DISPLAY FILE-MSG.
     ACCEPT TIMER-START FROM TIME.
     OPEN  INPUT SEQ-FILE1
          OUTPUT SEQ-FILE2.
     PERFORM 220-COPY-LOOP THRU 220-EXIT
        VARYING REC-COUNT FROM 1 BY 1
        UNTIL REC-COUNT > REC-LIMIT.
     CLOSE SEQ-FILE1, SEQ-FILE2.
     ACCEPT TIMER-END FROM TIME.
     PERFORM 2400-CALC-TIME THRU 2400-EXIT.
     DISPLAY ELAPSED-TIME.
 200-EXIT.    EXIT.

 220-COPY-LOOP.
     READ SEQ-FILE1.
     MOVE RECORD-1 TO RECORD-2.
     WRITE RECORD-2.
 220-EXIT.    EXIT.

 300-REL-FILE-I-O.
     MOVE "RELATIVE " TO FILE-TYPE.
     MOVE "WRITE" TO IO-TYPE.
     DISPLAY FILE-MSG.
     ACCEPT TIMER-START FROM TIME.
     OPEN OUTPUT REL-FILE3.
     PERFORM 310-REL-LOOP THRU 310-EXIT
         VARYING REC-NUM FROM 1 BY 1
         UNTIL REC-NUM > REC-LIMIT.
     CLOSE REL-FILE3.
     ACCEPT TIMER-END FROM TIME.
     PERFORM 2400-CALC-TIME THRU 2400-EXIT.
     DISPLAY ELAPSED-TIME.

     MOVE "READ " TO IO-TYPE.
     DISPLAY FILE-MSG.
     COMPUTE HALF-WAY = REC-LIMIT / 2 + 1.
     ACCEPT TIMER-START FROM TIME.
     OPEN INPUT REL-FILE3.
     PERFORM 320-REL-LOOP THRU 320-EXIT
         VARYING REC-COUNT FROM HALF-WAY BY 1
         UNTIL   REC-COUNT > REC-LIMIT.
     CLOSE REL-FILE3.
     ACCEPT TIMER-END FROM TIME.
     PERFORM 2400-CALC-TIME THRU 2400-EXIT.
     DISPLAY ELAPSED-TIME.

     MOVE "RD-WRT" TO IO-TYPE.
     DISPLAY FILE-MSG.
     COMPUTE HALF-WAY = REC-LIMIT / 2 + 1.
     ACCEPT TIMER-START FROM TIME.
     OPEN I-O REL-FILE3.
     PERFORM 330-REL-LOOP THRU 330-EXIT
         VARYING REC-COUNT FROM HALF-WAY BY 1
         UNTIL   REC-COUNT > REC-LIMIT.
     CLOSE REL-FILE3.
     ACCEPT TIMER-END FROM TIME.
     PERFORM 2400-CALC-TIME THRU 2400-EXIT.
     DISPLAY ELAPSED-TIME.
 300-EXIT.    EXIT.

 310-REL-LOOP.
     MOVE "RECORD"  TO REL-REC-WORD.
     MOVE REC-NUM   TO REL-REC-NUM.
     MOVE SPACES    TO REL-REC-TAIL.
     WRITE RECORD-3.
 310-EXIT.    EXIT.

 320-REL-LOOP.
     MOVE REC-COUNT TO REC-NUM.
     READ REL-FILE3.
     COMPUTE REC-NUM = REC-NUM - HALF-WAY + 1.
     READ REL-FILE3.
 320-EXIT.    EXIT.

 330-REL-LOOP.
     MOVE REC-COUNT TO REC-NUM.
     READ REL-FILE3.
     REWRITE RECORD-3.
     COMPUTE REC-NUM = REC-NUM - HALF-WAY + 1.
     READ REL-FILE3.
     REWRITE RECORD-3.
 330-EXIT.    EXIT.

 400-INX-FILE-WRITE.
     MOVE "INDEXED " TO FILE-TYPE.
     MOVE "WRITE"    TO IO-TYPE.
     DISPLAY FILE-MSG.
     COMPUTE HALF-WAY = REC-LIMIT / 2 + 1.
     MOVE ZERO TO COUNTER.
     ACCEPT TIMER-START FROM TIME.
     OPEN OUTPUT INX-FILE4.
     PERFORM 420-INX-LOOP THRU 420-EXIT
         VARYING REC-COUNT FROM HALF-WAY BY 1
         UNTIL   REC-COUNT > REC-LIMIT.
     CLOSE INX-FILE4.
     ACCEPT TIMER-END FROM TIME.
     PERFORM 2400-CALC-TIME THRU 2400-EXIT.
     DISPLAY ELAPSED-TIME.
 400-EXIT.    EXIT.

 420-INX-LOOP.
     MOVE "RECORD" TO INX-REC-WORD.
     MOVE REC-COUNT TO REC-KEY.
     ADD 1 TO COUNTER.
     MOVE COUNTER TO ALT-KEY.
     MOVE " ALT " TO ALT-WORD.
     MOVE SPACES  TO INX-REC-TAIL.
     WRITE RECORD-4.
     COMPUTE REC-NUM = REC-COUNT - HALF-WAY + 1.
     MOVE "RECORD" TO INX-REC-WORD.
     MOVE REC-NUM TO REC-KEY.
     ADD 1 TO COUNTER.
     MOVE COUNTER TO ALT-KEY.
     MOVE " ALT " TO ALT-WORD.
     MOVE SPACES  TO INX-REC-TAIL.
     WRITE RECORD-4.
 420-EXIT.    EXIT.

 500-INX-FILE-READ.
     MOVE "READ"    TO IO-TYPE.
     DISPLAY FILE-MSG.
     MOVE ZERO TO REC-NUM.
     ACCEPT TIMER-START FROM TIME.
     OPEN INPUT INX-FILE4.
     PERFORM 520-INX-LOOP THRU 520-EXIT
         VARYING REC-COUNT FROM REC-LIMIT BY -1
         UNTIL   REC-COUNT < HALF-WAY.
```

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```
    CLOSE INX-FILE4.
    ACCEPT TIMER-END FROM TIME.
    PERFORM 2400-CALC-TIME THRU 2400-EXIT.
    DISPLAY ELAPSED-TIME.
500-EXIT.   EXIT.

520-INX-LOOP.
    MOVE REC-COUNT TO REC-KEY.
    READ INX-FILE4 KEY IS REC-KEY
       INVALID KEY GO TO 990-STOP.
    ADD 1 TO REC-NUM.
    MOVE REC-NUM TO REC-KEY.
    READ INX-FILE4 KEY IS REC-KEY
        INVALID KEY GO TO 990-STOP.
520-EXIT.   EXIT.

600-INX-FILE-IO.
    MOVE "RD-WRT"  TO IO-TYPE.
    DISPLAY FILE-MSG.
    MOVE 200  TO COUNTER.
    MOVE ZERO TO REC-NUM.
    ACCEPT TIMER-START FROM TIME.
    OPEN I-O INX-FILE4.
    PERFORM 620-INX-LOOP THRU 620-EXIT
        VARYING REC-COUNT FROM REC-LIMIT BY -1
        UNTIL   REC-COUNT < HALF-WAY.
    CLOSE INX-FILE4.
    ACCEPT TIMER-END FROM TIME.
    PERFORM 2400-CALC-TIME THRU 2400-EXIT.
    DISPLAY ELAPSED-TIME.
600-EXIT.   EXIT.

620-INX-LOOP.
    MOVE REC-COUNT TO REC-KEY.
    READ INX-FILE4 KEY IS REC-KEY
       INVALID KEY GO TO 990-STOP.
    SUBTRACT 1 FROM COUNTER.
    MOVE COUNTER TO ALT-KEY.
    REWRITE RECORD-4.
    ADD 1 TO REC-NUM.
    MOVE REC-NUM TO REC-KEY.
    READ INX-FILE4 KEY IS REC-KEY
       INVALID KEY GO TO 990-STOP.
    SUBTRACT 1 FROM COUNTER.
    MOVE COUNTER TO ALT-KEY.
    REWRITE RECORD-4.
620-EXIT.   EXIT.


990-STOP.
    DISPLAY "INVALID KEY   ", REC-KEY.
    STOP RUN.

* COPY TIMERPRO for RM, COPY "TIMERPRO.CBL" for Realia.
    COPY TIMERPRO.
```

LISTING 4: DISPLA.COB

```
IDENTIFICATION DIVISION.
PROGRAM-ID.  DISPLA.

*                          SCREEN DISPLAY BENCHMARK

ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER.  IBM-PC.
OBJECT-COMPUTER.  IBM-PC.

DATA DIVISION.

WORKING-STORAGE SECTION.

77  SCREEN-LINE              PIC X(72).

01  CLEAR-1.
    05  ESC-LEFT-BRACK       PIC S9999 COMP  VALUE 7003.
    05  TWO-J                PIC XX          VALUE "2J".
01  CLEAR-SCREEN   REDEFINES CLEAR-1         PIC XXXX.
* COPY "TIMERDAT.CBL" for RMC, COPY TIMERDAT FOR Realia

COPY TIMERDAT.

PROCEDURE DIVISION.
000-MAINLINE.
    MOVE ALL "O" TO SCREEN-LINE.
    ACCEPT TIMER-START FROM TIME.
    PERFORM 120-DISP-LOOP THRU 120-EXIT 10 TIMES.
    ACCEPT TIMER-END FROM TIME.
    PERFORM 2400-CALC-TIME THRU 2400-EXIT.
    DISPLAY ELAPSED-TIME.
    STOP RUN.

120-DISP-LOOP.

* FOLLOWING LINE FOR RMCOBOL ONLY
*    DISPLAY " " LINE 1 POSITION 1 ERASE.
* FOLLOWING LINE FOR REALIA ONLY
    DISPLAY CLEAR-SCREEN.

    PERFORM 130-DISP-LOOP THRU 130-EXIT 25 TIMES.

120-EXIT.   EXIT.

130-DISP-LOOP.
    DISPLAY SCREEN-LINE.
130-EXIT.   EXIT.

* COPY "TIMERPRO.CBL" for RMC, COPY TIMERPRO FOR Realia
 COPY TIMERPRO.
```

LISTING 5: TIMERPRO.COB

```
*
* COPY FILE OF PROCEDURE STATEMENTS FOR TIMER CALCULATIONS
*   NAME IS TIMERPRO.COB FOR REALIA,
*           TIMERPRO.CBL FOR RM

2400-CALC-TIME.
    ADD 1 TO TIM1-HH.
    ADD 1 TO TIM2-HH.
    MOVE TIM2-MM TO TIM3-MM.
    MOVE TIM2-SS TO TIM3-SS.
    IF TIM3-MM = ZERO OR TIM3-MM < TIM1-MM
        SUBTRACT 1 FROM TIM2-HH
        ADD     60  TO  TIM3-MM.
    IF TIM3-SS = ZERO OR TIM3-SS < TIM1-SS
        SUBTRACT 1 FROM TIM3-MM
        ADD     60  TO  TIM3-SS.
    SUBTRACT TIM1-HH FROM TIM2-HH GIVING ELAPSED-HH.
    SUBTRACT TIM1-MM FROM TIM3-MM GIVING ELAPSED-MM.
    SUBTRACT TIM1-SS FROM TIM3-SS GIVING ELAPSED-SS.
2400-EXIT.   EXIT.
```

LISTING 6: TIMERDAT.COB

```
*
* COPY FILE OF DATA NAMES FOR TIMER CALCULATIONS
*    NAME IS TIMERDAT.COB FOR REALIA,
*            TIMERDAT.CBL FOR RM

01  TIMER-START.
    05  TIM1-HH                    PIC 99.
    05  TIM1-MM                    PIC 99.
    05  TIM1-SS                    PIC 99V99.
01  TIMER-END.
    05  TIM2-HH                    PIC 99.
    05  TIM2-MM                    PIC 99.
    05  TIM2-SS                    PIC 99V99.
01  TIMER-DIFF.
    05  TIM3-MM                    PIC 999.
    05  TIM3-SS                    PIC 999V99.
01  ELAPSED-TIME.
    05  FILLER       PIC X(13) VALUE "ELAPSED TIME ".
    05  ELAPSED-HH                 PIC 99.
    05  FILLER                     PIC X  VALUE ":".
    05  ELAPSED-MM                 PIC 99.
    05  FILLER                     PIC X  VALUE ":".
    05  ELAPSED-SS                 PIC 99.99.
```

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—Mark DaVia/National Microware, Inc.

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—Chris MacNeil/Abel Computers

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—Michael Broska/Agate Systems, Inc.

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—Dave Browning, Chairman/
Database SIG, Capital PC Users Group

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—Phillip Wood, Director of Data Processing/Search Institute

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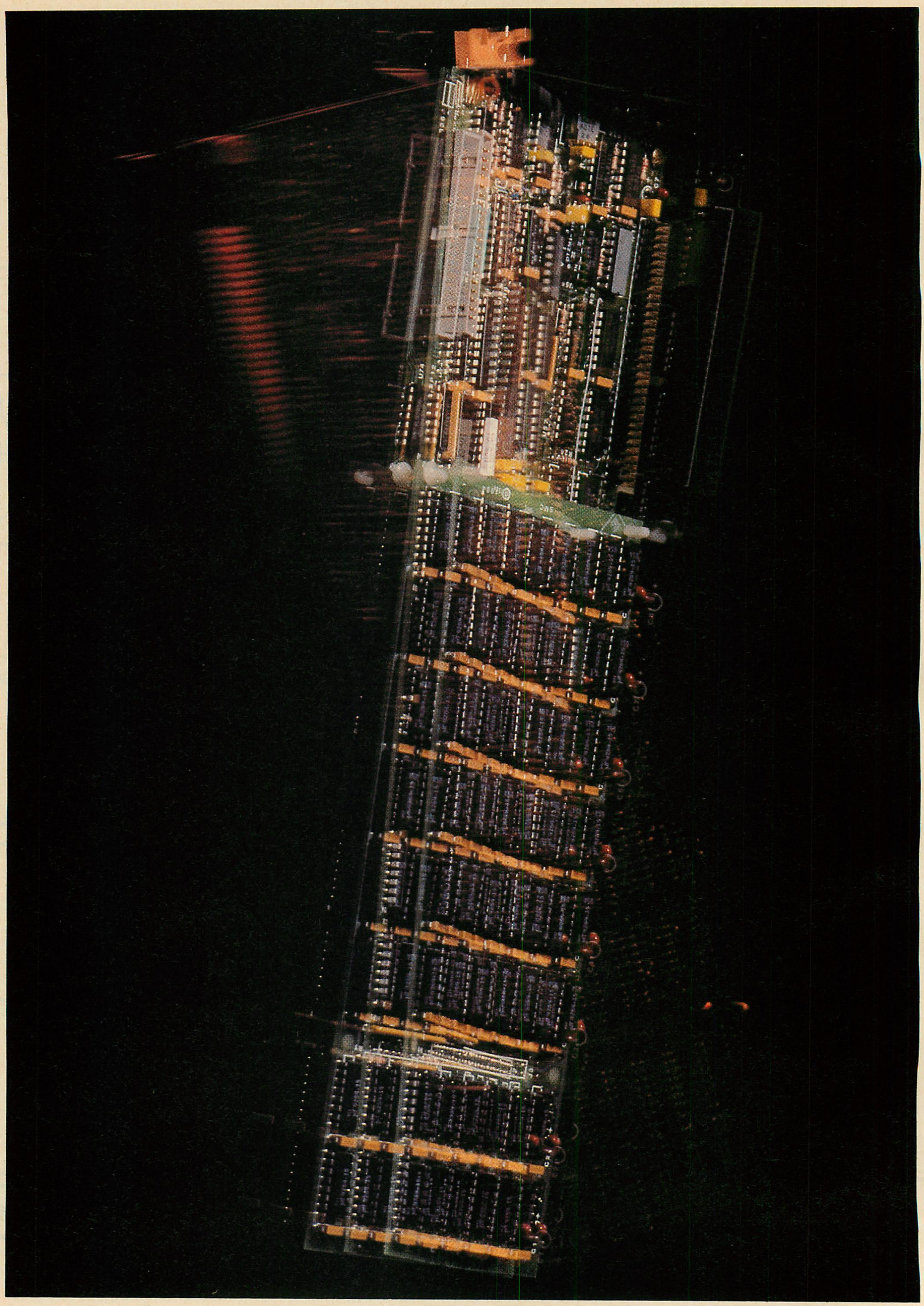

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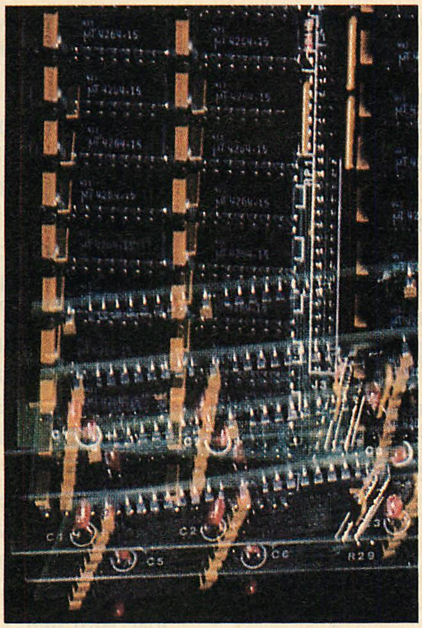
Exceeding the Speed Limit

The PC's speed can be increased as much as three times with accelerator boards from Kamerman and Orchid.

TOM PUCKETT



The speed with which a PC executes a task is always a critical matter to the user. The demand for greater speed has been a given in the computing industry since its beginning. One way to approach the problem of increasing speed is to restructure the computation itself so that it requires fewer resources. This is often done in dealing with scientific problems; the fast Fourier transform is a good example. Another approach is to use improved software development tools, such as optimizing compilers. A third approach is to add hardware to the computer to make the CPU run faster. Two such CPU-accelerator boards are reviewed here: Kamerman Labs' Superflight and Orchid Technology's PCturbo-186. Table 1 summarizes their features.

The Superflight board does its job by replacing the PC's Intel 8088 processor chip with an 8086 chip. The 8086 runs at twice the speed of the 8088 and has a 16-bit bus interface rather than the 8-bit interface of the 8088. PCturbo-186 supplements the 8088 with an 80186 processor. The 80186 serves as the primary processor; it runs at 8 mHz—about two-thirds faster than the 8088—and uses a 16-bit bus interface. The 8088 serves as a subsidiary processor handling peripheral I/O devices, such as disks and printers.

Both boards can increase the speed of the PC by two to three times when performing common computing tasks. Of course, some operations—for example, tasks such as copying one floppy disk to another—are almost completely I/O bound; speeding up the processor will make no practical difference in the time required to perform the operation. However, the speed of tasks such as recalculation of large in-memory spreadsheets can be improved; these boards can reduce the time required for these tasks to one-half to one-third the time previously required.

All electronic components have inherent speed limitations, but other limi-

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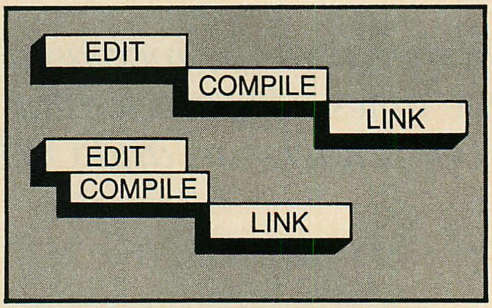

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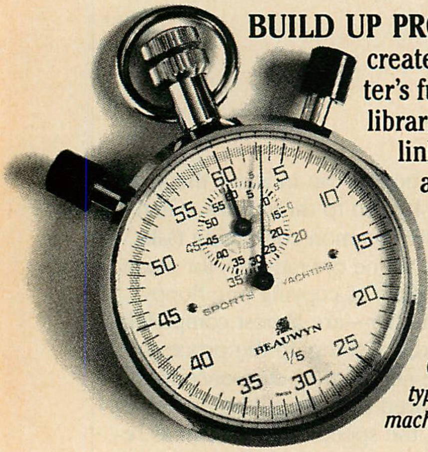

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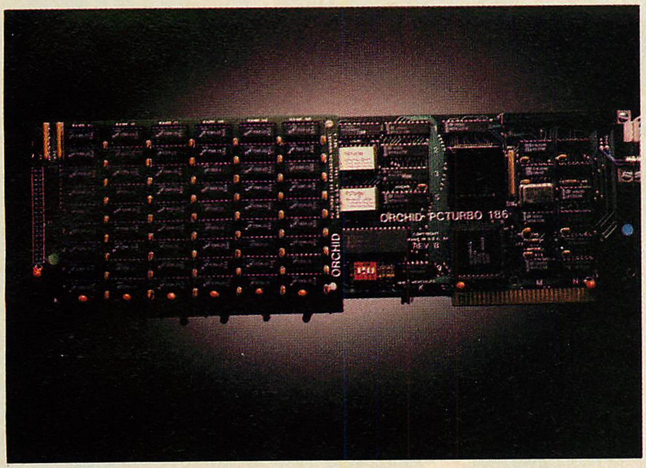
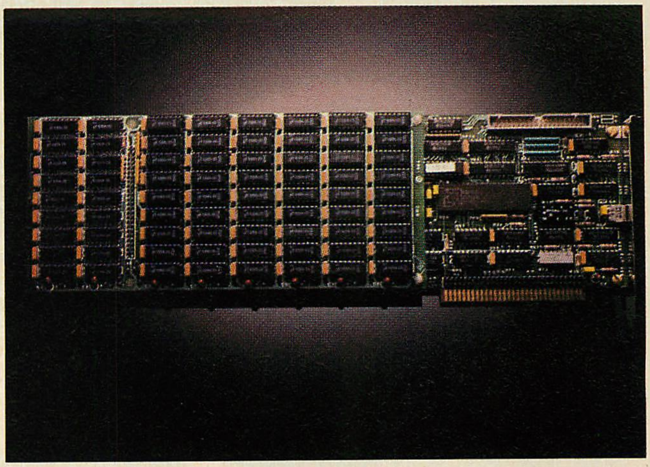
PHOTO 1: *Orchid Technology's PCturbo-186*



The board shown here has a filled daughterboard for a total of 640KB RAM. The chip carrier with the finned heatsink is the 80186; the other is a custom gate array.

PHOTO 2: *Kamerman Labs' Superflight*



This unit has a filled daughterboard and 640KB RAM. A ribbon cable from the header connector runs to a plug that replaces the 8088 on the PC motherboard.

tations are imposed by the organization of the processor and the architecture of the computer. Figure 1 shows the organization of the IBM PC in simplified terms. The Execution Unit (EU) and Bus Interface Unit (BIU) are the two primary elements of the 8088 chip, and they run somewhat independently. The EU is concerned with the actual interpretation of instructions; the BIU fetches and stores data and instructions over the Multiplexed Bus.

An important aspect of the BIU is that it attempts to anticipate the EU's needs for instructions. On speculation, before it has been requested to do so by the EU, the BIU fetches instructions that follow the currently executing instruction and stores them in the Instruction Queue. Only in the relatively rare situations of transfer of control will this be wasted effort, so most of the time the EU finds its next instruction already present in the queue. This overlapping of activity by the chip's two primary elements, EU and BIU, greatly increases the overall speed of the processor.

The Multiplexed Bus handles the transfer of instructions and data between the 8088 and main storage. In addition, it manages the bulk transfer of data between main storage and peripheral devices, such as disk drives. Data transfers to and from peripheral devices are under the sponsorship of a Direct Memory Access (DMA) controller, so they go only to main storage, never directly to the 8088. DMA transfers take priority over 8088 transfers, because the data flow from a moving mechanical device, such as a disk, cannot conveniently be suspended if a conflict for bus access were to develop.

The effective speed of systems of this nature cannot be defined simply. The EU, the BIU, and the DMA controller all can perform independent actions simultaneously, which causes complex interactions. The amount of conflict for shared resources, such as storage and the bus, depends upon the nature of the computation under way and the details of the data being processed. The speed of main-storage access affects the frequency of conflict for bus control. If the computation involves significant data movement between storage and slower peripherals such as floppy disks, the speed of the disk drive is often the only thing that matters.

Awkward interactions can take place between software and hardware. An example as old as rotating media is that of reading successive sectors of data from a disk drive. The data on a single track of a floppy drive is typically divided into eight or nine sectors. Suppose a sector is read in and processed by a program in a little less time than is required for one complete rotation of the disk. A read for the next sector can then be set up and initiated just as the sector comes under the read/write heads of the drive. Now suppose the program is changed so that the time required to process a sector is increased only slightly, but still enough that it takes slightly longer than one rotation of the disk drive to be ready to read the next sector. Unfortunately, this means the sector to be read has just passed the read/write heads, and another full rotation of the disk must occur. A minor program change thus leads to a sudden jump from one rotation time to two for processing each sector.

Because of all these interactions, the only sure way to increase the speed of a system is to increase the speed of all the elements: the EU, the BIU, storage, and the peripheral devices. The speed of a particular computation, however, is often limited only by one or two elements of a system, and in such cases selective improvements can make a big difference. The classic example of such an improvement is the use of a RAM disk as a replacement for a disk drive: a portion of main storage is set aside to simulate the disk, with effective access and transfer times of perhaps one-tenth those of a real disk. For I/O-bound computations, the improvement is naturally dramatic.

Another, more architectural, route to faster operation falls under the general heading of doing more things in parallel. The particular case of interest is the bus: within the IBM PC, the bus handles 8 bits at a time. If the structure is changed so that 16 bits are handled at once, data transfers will be significantly faster. This is particularly appropriate to consider because many elements of the 8088 design, such as the registers, are already 16 bits wide.

The 8088 itself is not adaptable for this purpose, because the 8-bit bus is a fixed element of the BIU and main-storage design. The 8086, however, does offer a 16-bit BIU. In fact, Intel specifically identifies the two chips as having identical execution units; the essential differences are in the BIU. In addition to a wider bus, the 8086 has a 6-byte instruction prefetch queue, compared to a 4-bit queue on the 8088. The prefetch algorithms also differ: the 8088 BIU will fetch another instruction byte as soon

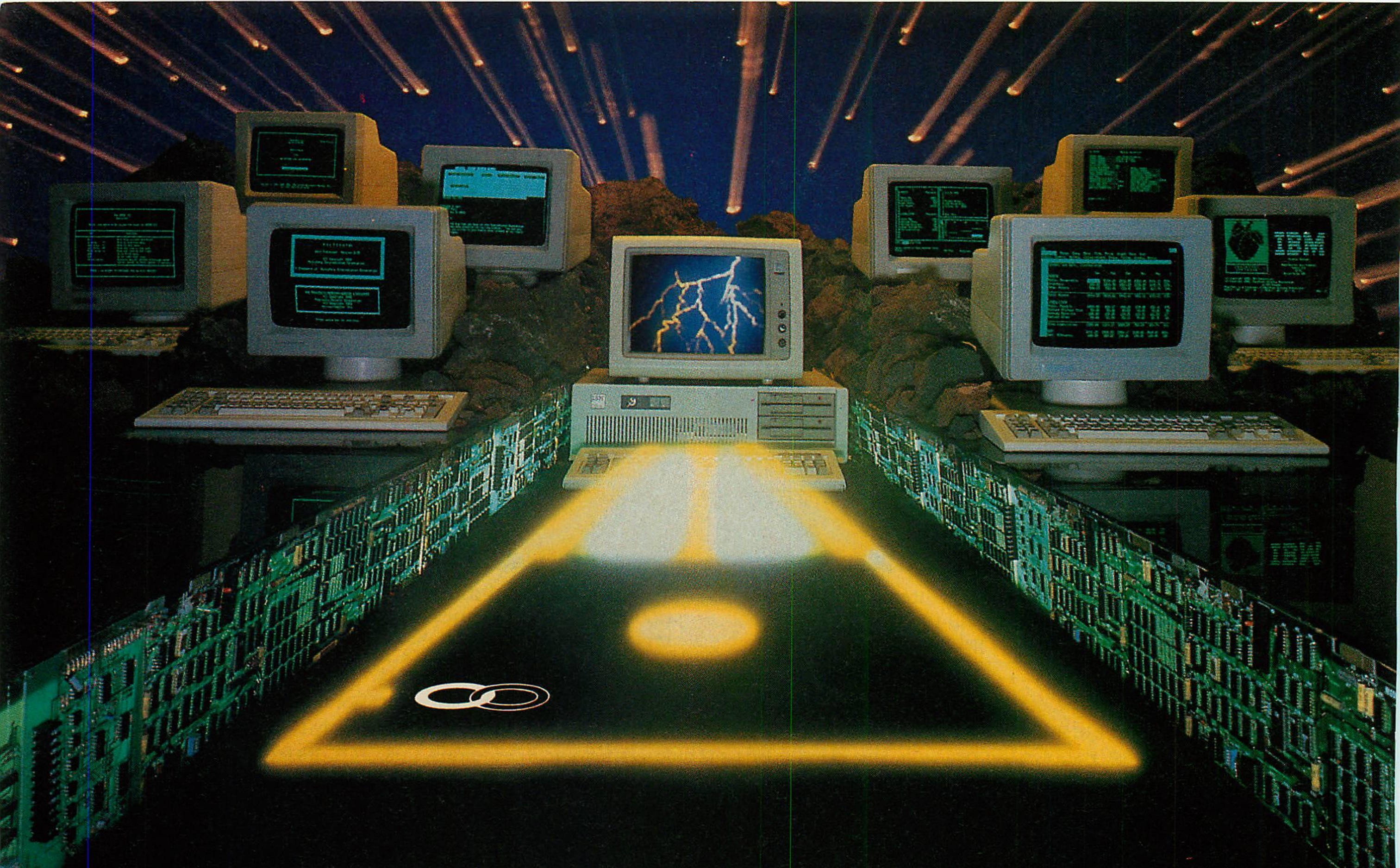


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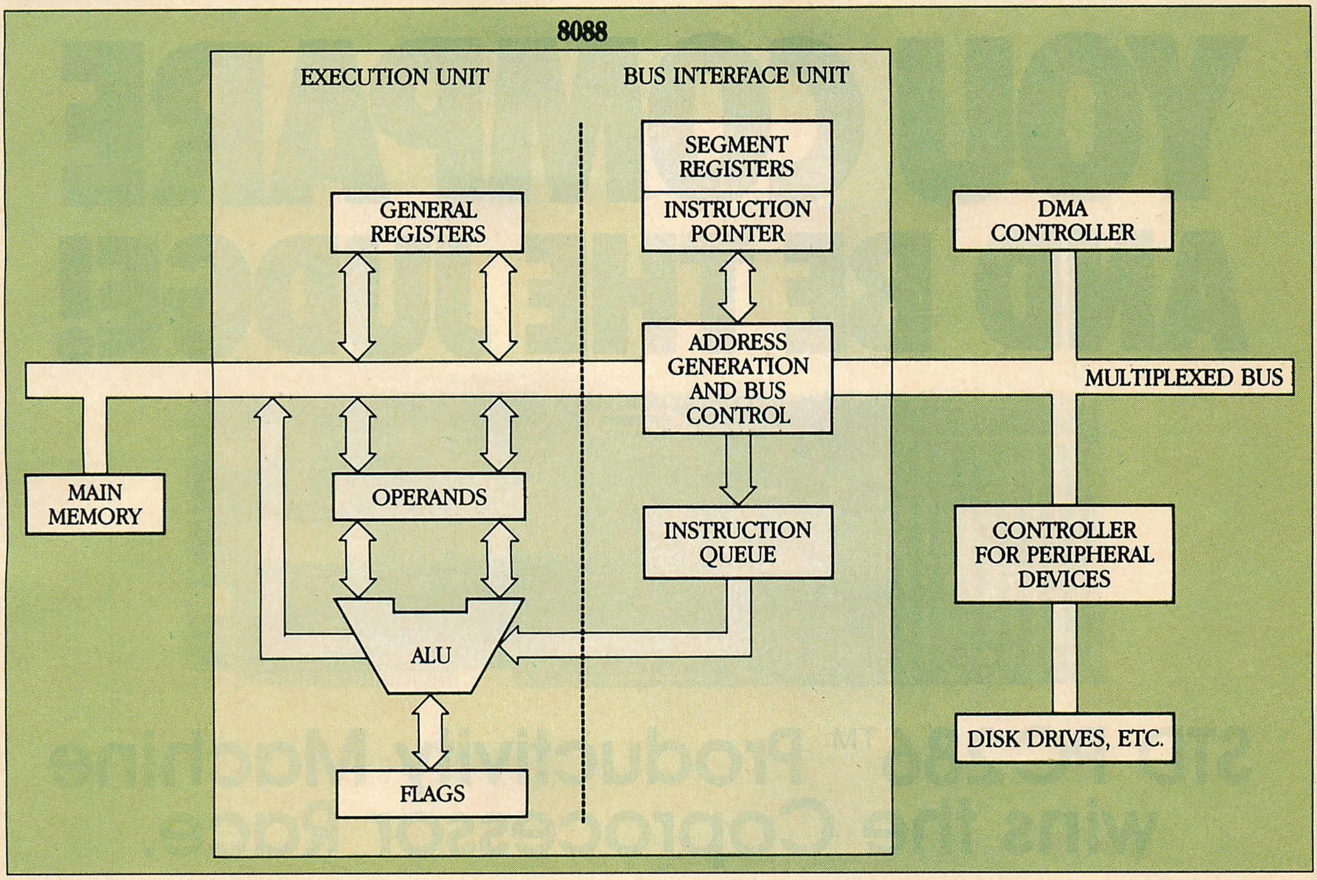
FIGURE 1: *PC Organization*



Illustrated here is the organization of the PC in simplified terms. The Execution Unit (EU) and Bus Interface Unit (BIU) are the two primary elements of the 8088 processor chip, and they run somewhat independently.

as there is a single vacancy in its queue, whereas the 8086 BIU waits until 2 bytes are vacant in the queue.

The 8086 offers another advantage over the 8088: one of its models can be run at twice the speed of an 8088. The use of a double-speed 8086 in conjunction with a 16-bit bus and main storage are the major facilities offered by the Superflight board.

PCturbo-186 offers these same facilities through the use of the Intel 80186 chip. The 80186 and 80188 devices are similar to the 8086 and 8088 units, but with a number of improvements. They are highly integrated, effectively combining 15 or 20 of the components needed by the 8086/88 chips. Functions moved on-chip include two DMA channels, three timers, an interrupt controller, and a clock generator. Address calculations are quicker, the closer integration allows many instructions to execute more quickly, and there are ten instructions and three interrupts not present in the 8086/88 devices.

The 80186 is run at 8 mHz, so the processor speed is not increased as much as with Superflight. However, other interesting steps are taken to increase overall performance. One such step is to leave the 8088 in use as an I/O processor, thus relieving some of the burden on the 80186. Another possibility is to use the storage that is associated with the 8088 as a cache to improve I/O performance.

A *cache* is essentially a fast-access temporary buffer for data properly associated with a slower device. Suppose, for example, some data are destined to be written to a floppy disk. They are first written from 80186 main storage to a buffer in 8088 storage. This write will be relatively quick compared with writing to an actual disk. This is similar to the situation that occurs with a RAM disk. The 80186 side of the system then goes on its way, and the 8088 takes on the job of seeing to it that the data are eventually written to their true destination on the floppy disk. This process usually produces a significant improvement because there is more of an overlap in processing and I/O activity.

Some beneficial statistical factors also help out. Programs often access only a limited span of data over extended periods. Consider a program that reads in the same data several times, perhaps modifies it, and then rewrites it. If a cache is in use, the data will have been read into a buffer by the 8088 and then passed to the 80186. No particular time is saved so far. Further accesses to the same data, however, are really only accesses to the cache buffer, so I/O time disappears.

Another common situation is for a program to read sequentially through a set of data. A cache manager can anticipate this, reading the next data from a disk upon speculation that the program will want it next. This is exactly what the BIU does for the 8086/88 EU in fetching instructions.

Implementation of a cache is not a trivial matter. There are never enough buffers for the cache manager to store all the data, so a scheme must be in place to reallocate buffers as needed. A typical approach is to use an algorithm that selects for reuse the buffer that has been out of use for the longest time. Complications, such as having the same data residing in both a cache buffer and on disk, also must be handled. Some-

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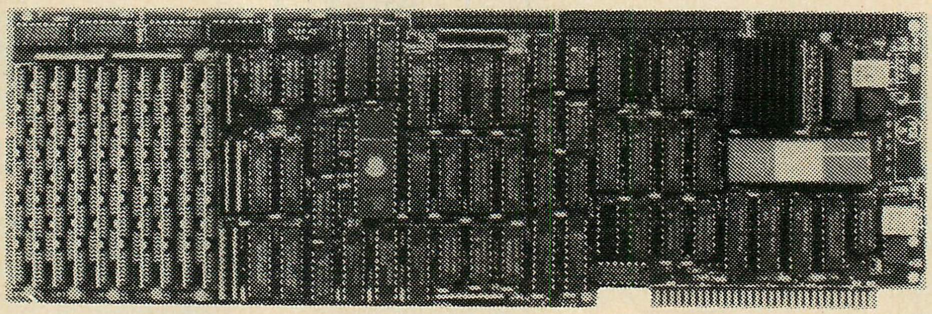

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times only one of the locations will contain valid data, and confusion on this matter by the cache manager will quickly result in corrupt data.

SUPERFLIGHT DETAILS

The tested Superflight board contained 640KB of storage but no options (added ports, for example). Installation of the board requires removal of the 8088 chip from the system board. An extension cable runs from the board and plugs into the 8088 socket. Some care must be taken to install this cable with the correct orientation and to avoid bending the pins. This cable also tends to catch on the system unit cover when the cover is being removed. An extraction tool is provided to assist in removing the 8088, but it is better suited for removing smaller memory chips.

If Superflight is to be installed in a PC (rather than a PC/XT) system unit that contains an 8087 numeric coprocessor, the instructions recommend removing the 8087 to reduce power consumption. The instructions also advise that the system-unit switch settings should be adjusted accordingly, but no guidance is given as to which adjustment is to be made or where the information may be found. It is probably mandatory to remove an 8087, because those usually sold for the PC are not rated for operation at the higher clock rate of Superflight's 8086.

Commonly, programs that use an 8087 first test for its presence and use emulation routines if it is not available. Such programs will continue to execute without the 8087, but at much slower speeds. The 8087 is typically quoted as being up to 100 times as fast as emulation routines in the processing of floating-point data.

If Superflight has less than 640KB of storage, it will use existing storage already in the machine up to its limit of 640KB. This storage is accessed through the PC's 8-bit bus, however, so some of the potential performance gain that would be provided by Superflight's 16-bit bus is not realized.

Because of the close relationship between the 8086 and 8088 chips, incompatibilities should be anticipated only in special situations. Games that were designed purposely to depend upon the speed characteristics of the hardware are the most likely to misbehave. In order to deal with this, the board carries a manually operated switch on the rear panel that causes it to operate at normal PC speed. The speed also can be controlled through software by writing to an I/O port.

TABLE 1: *Feature Summary*

	SUPERFLIGHT	PCTURBO
COMPANY	Kamerman Labs	Orchid Technology
PRICE W/256KB	$1,360	$1,160
PRICE W/640KB	$1,900	$1,430
COMPUTER	IBM PC	IBM PC
PROCESSOR(S)	8086	80186/8088
CLOCK RATE	9.54 mHz	8 mHz
MIN. SYSTEM UNIT STORAGE	64KB	256KB
MAX. HIGH-SPEED STORAGE	640KB	640KB
DOCUMENTATION	21 pages	71 pages
OPTIONS	Serial port, parallel port, clock/calendar	
ADDITIONAL FEATURES		RAM disk, I/O cache

Both accelerator boards require full-length slots and both use a piggy-back extension at maximum storage configuration, taking up two slots on a PC/XT.

Another possible source of incompatibility arises because the 8086 prefetch queue is 6 bytes long, compared to 4 bytes on the 8088. A few programs use the dubious technique of modifying code just before it is executed. If the modified code is 4 to 6 bytes "upstream" in memory it should perform on an 8088, but it may fail on an 8086.

Superflight requires that a 64KB segment of the machine's address space be set aside for DMA translation purposes. The default is the block starting at 640KB. Switches are provided on the board for selecting a different starting address if this block is already in use for other purposes, such as supporting the IBM Enhanced Graphics Adapter.

The documentation provided with Superflight is clear and straightforward, but some details—such as how to adjust the system-unit switch settings after an 8087 has been removed—were missing.

Two boards were tested in an IBM PC with a 64KB system board. When the first board was used, the system would fail after about an hour. This problem could have resulted from an inadequate power supply in the system unit. After an exchange of boards was made, the problem did not reappear. Incidental environmental aspects (room temperature, for example) may have made the difference in performance.

PCTURBO-186 DETAILS

The PCturbo-186 approach is considerably more complex than that of Superflight. PCturbo-186 adds an independent processor to the system, and requires considerable software involvement for communication, control, and coordination. DOS 2.0 or later is required.

In general operation, DOS is first booted by the 8088 in normal fashion, the PCturbo-186 board remaining inactive. If desired, the PC may be operated as if the board were not present. The board is brought into service by execution of the TURBO.COM program, either as the result of a statement entered by the user or automatically via the AUTOEXEC.BAT file.

The TURBO.COM program does several things. The remaining free storage associated with the 8088 is organized as an I/O cache, and the 8088 is set up to manage the cache and I/O processing for the 80186. PCturbo-186 is activated and the 80186 brought into use; the first action is the booting of a *second* copy of DOS in the 80186's storage. A special device-driver linkage is established so that the second copy of DOS has access to all the devices of the first copy originally brought up on the 8088 side of the system.

The 80186's copy of DOS runs independently in the chip's fast-access storage, calling on the 8088 as needed for I/O processing. DOS start-up actions usually must be repeated for the 80186 copy. These actions might include setting up environmental information with the PATH command, adjusting system parameters such as the command prompt, and reinitializing devices such as printers with any special set-up information. The decisions that are necessary to control these actions are made easier by the availability of utility programs that allow batch files to determine whether the 8088 or 80186 is currently in control of the machine—that is, the programs determine which copy of DOS is currently active.

PCturbo-186 handles the compatibility issue by allowing a return to 8088 control and the first copy of DOS whenever desired. For example, the 80186

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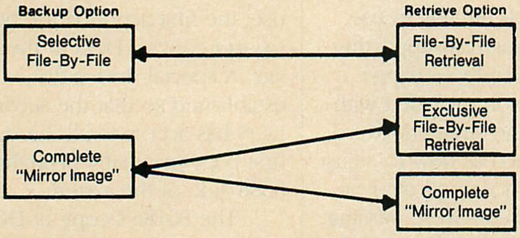

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TABLE 2: *Test Results*

SOURCE AND LIBRARY FILES ON DISKETTE DRIVE

	COMPILE TIME	LINK TIME
Nonaccelerated PC	113 seconds	54 seconds
Superflight	80	45
PCturbo-186	58	50

SOURCE AND LIBRARY FILES ON RAM DISK

	COMPILE TIME	LINK TIME
Nonaccelerated PC	61 seconds	21 seconds
Superflight	22	7
PCturbo-186	26	10

Above are the times required to compile and link the FXU.C program, supplied with Lattice C, with source and library files on diskette drive and RAM disk.

cannot access communications ports or run the IBM ROM BASIC interpreter. When access to these facilities is required, a program that is similar to TURBO.COM is executed; this program suspends 80186 processing and returns control to the 8088 and the initial copy of DOS. TURBO.COM may be reinvoked at any time to repeat its original processing and reactivate the 80186. It is possible to bounce back and forth this way as often as necessary.

The tested PCturbo-186 board contained 640KB of storage. The mechanical installation requires simply the insertion of the board into an empty slot. Several rather extensive batch files are provided to automate the various software installation possibilities, which depend upon whether the system is booted from a floppy disk or a fixed disk. A user on good terms with DOS concepts, such as use of the AUTOEXEC.BAT and CONFIG.SYS files, may find it a more straightforward method to review the discussion in the documentation and then take the necessary steps directly.

Two PCturbo-186 boards were tested using an IBM PC. The first board suffered continuing operating failures, usually resulting in parity check hangups. The cause of these problems is not clear, but again it may be that the PC power supply is not adequate for the needs of the board. The board was exchanged for one with CMOS chips that require less power, and the difficulties disappeared. (Orchid Technology says that an even better "Revision B" board is in the works that will replace 20 chips with a VLSI gate array and provide a connection to the 80186 bus for new products. In the other direction, the documentation gives indications that some of the original PCturbo-186 boards may have been produced with 6-mHz 80186 chips, rather than the 8-mHz chips used in the later version.)

The documentation was somewhat crude and could have been better organized (no index is provided). It does contain all the necessary information to get the board installed and running. Some surprises could have been avoided if more details had been given about which programs would have to be run on the 8088 side. ROM BASIC is mentioned, but not DISKCOPY. In general, software that makes use of hardware interrupts or DMA (see below) will fail if it is run under the 80186. For example, when a fixed-disk back-up program was tried on the 80186, the program cheerfully and almost instantaneously indicated successful completion of the back-up, without ever reading anything from the disk. Orchid indicated that DMA access was probably to blame and that the program (which was thoroughly I/O bound, in any event) would gain little speed from the 80186 and should run correctly under the control of the 8088.

Orchid also provided a draft copy of a technical reference manual for its board. It contained some details on the PCturbo hardware and on user program access to the 80186/8088 communications facilities. Unfortunately, the section describing the programs that interact with DOS was missing.

The 80186 has a 6-byte prefetch queue, so self-modifying programs suffer the same risk of improper operation as when run on an 8086. The 8087 is not supported by PCturbo-186. Programs that attempt to access low-level hardware features, such as the system timer, may be in for surprises, because the board uses the 80186's built-in facilities rather than the outboard chips used by the 8088. The 80186 uses the PC's DMA channel 3 for its own purposes, but on a shared basis that should avoid conflicts with other uses. (This was not borne out in testing, however, as discussed earlier.)

In addition, a utility program is provided that modifies TURBO.COM so that DMA channel 1 is used instead of DMA channel 3 if this is necessary to avoid a conflict. PC Interrupt 7 is also used by PCturbo-186. This interrupt is nominally for printer support, but in practice it is rarely used.

The cache is not normally used for diskette I/O, because there is no automatic way to know if the user has changed diskettes. If a diskette change is made without the system being made aware of it, a later write of a cache buffer would update the wrong record and most likely destroy the contents of the diskette. An option is provided to do cache buffering on diskettes, but the user must always remember to signal when a diskette change is made. This is a dangerous option and should be used only with great care.

PERFORMANCE

An application involving substantial amounts of both computation and I/O activity was selected as the primary test vehicle. To bracket the effects of disk speeds the tests were run twice, the first time with the data and library files on a floppy diskette and the second time using a RAM disk. Results with hard disks will fall somewhere between the results for these two cases. In both cases, the programs that were executed resided on a RAM disk. Two programs were run: compiling the FXU.C program supplied with the Lattice C compiler and linking the resulting object module. The results for both sets of tests are given in table 2.

As the values in table 2 would indicate, it is important to test enhancements such as these with truly representative data. If, for example, the workload to be processed consists solely of link runs using floppy disks, neither of these boards will significantly impact performance. At the other extreme, a link run with a combination of a RAM disk and Superflight yields an improvement of almost eight to one, with the PCturbo-186 not far behind.

A second useful observation is that if disk activity—particularly floppy disk activity—is a significant part of a job mix, a RAM disk by itself, without any kind of CPU accelerator board, can be a

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Probably the most computationally intensive task many people call upon their computers to perform is spreadsheet recalculation. Those persons whose business enterprises or living depends on complex spreadsheet models in Lotus 1-2-3 or SuperCalc might find that a CPU accelerator board could prove to be a significant productivity enhancer.

In connection with this article, *PC Tech Journal* developed a simple spreadsheet recalculation benchmark in Lotus 1-2-3 with which the Kamerman Superflight and Orchid PCturbo-186 boards were tested. To bracket the performance range of the IBM product line, the benchmark recalculation was also run on a 256KB PC and a 640KB PC/AT.

The benchmark spreadsheet used here is simple in structure: one hundred rows of ten columns of cells, each of which performs the following calculation on value X contained in the cell to its left:

@LN(@SQRT(X* 1.01)+1)

The first cell in each row calculates *X* based on the value of the last cell in the row above it. The first cell in the top row takes its value from a cell immediately above it, which contains no formula. Changing the value of this initial cell begins the recalculation. The results in the accompanying table were timed with a stopwatch. Three separate timings were taken for each case and the average calculated. The physical spreadsheet file (SSBENCH. WKS) will be available on the *PC Tech Journal* Listings Diskette and the new PCTJ Bulletin Board.

BENCHMARK RESULTS

PC/AT (6 mHz 80286)	15.56 seconds
PCturbo-186 (8 mHz 80186)	20.25
Superflight (9.54 mHz 8086)	20.35
IBM PC (4.77 mHz 8088)	47.91

The results are dramatic: an accelerator board more than doubles the recalculation throughput of a typical spreadsheet on an unenhanced PC. Interestingly, the timings for the Superflight and PCturbo boards are identical to within one-half of one percent.

To shave another 25 percent off the time, the user could, of course, upgrade to an AT. But for the money, it would appear that either of the CPU accelerator boards will make a PC crunch spreadsheets like nothing else on the market.

—JEFF DUNTEMANN

worthwhile investment. The files placed on the RAM disk for these tests took up less than 100KB (mostly for the library file). Using a rough figure of $1 for each 1KB of storage used for the RAM disk, an investment of $100 produces a performance improvement not far from two to one in the less favorable case.

It can be argued that the volatile RAM disk is not a good place to store source data. This is true, however the source file could be kept on a floppy and simply copied to the RAM disk just before each compilation. The additional time for the copy would not change the results appreciably.

A comparison of the values for Superflight and PCturbo-186 gives the edge to Superflight in three of the four cases. However, the values differ only by about 10 to 30 percent.

It is not possible with simple tests such as these to be sure which of the various elements is having the most impact, but it is interesting to speculate that the PCturbo-186 cache is not benefiting I/O processing as much as expected. One reason may be that the overhead of 80186/8088 communication and cache management might be high enough to negate the benefits. Another is that DOS uses buffering techniques for disk I/O that already provide some of the features of a cache, so the added benefit from the PCturbo-186 cache is not as great as it would be otherwise.

In general, these two boards are attractive products. They offer an effective way to upgrade an existing machine with significant additional capacity. The two products provide similar performance improvements, and a choice between them should be made on other grounds. To what extent performance is improved depends heavily upon just what is being run on a system and on the configuration of the system. For mixed job streams, such as the ones tested, improvement factors of two or three to one should be common. The more processor-bound (rather than I/O-bound) a computing task is, the more these boards can be expected to positively impact speed performance.

Some cautions should be mentioned. These accelerator boards are complex hardware, each containing what amounts to a nearly complete computer system. It would be prudent to be sure that service arrangements are completely defined and will be acceptable under the worst conditions. Only PCturbo-186 comes with diagnostic support, and that is only for testing storage. Some awkwardness may arise if service for the PC is not obtained from the same source as service for the accelerator board—the board may have to be removed and the PC restored to its original configuration. Users whose processing is heavily dependent upon the use of the 8087 chip will probably not want to use these boards.

There are also software questions to consider with PCturbo-186. Because the software is proprietary, it is difficult to evaluate the extent to which it interacts with DOS and whether there is potential for difficulty in adapting to future releases of DOS or a likelihood of incompatibility with complex new features, such as the IBM PC-Network. To users who run only a few standard applications these questions are probably not important, but a software developer whose system runs with all the bells and whistles of the latest packages and operating systems might want to reflect on the possible complications before making a commitment.

PCturbo-186: with 128KB, $895 (each additional 64KB is $45); 128KB expansion board, $265
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415/490-8586
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Superflight: with 128KB, $1,095; 128KB piggy-back board, $315 (each additional 128KB, $180); I/O board, $315
Kamerman Labs
8054 SW Numbus Avenue
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Beaverton, OR 97005
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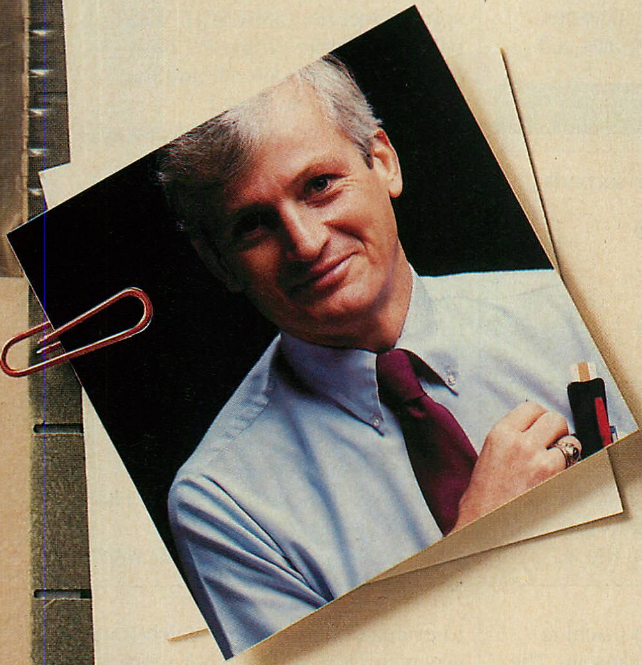
Tom Puckett is a senior systems programmer for STSC, Inc. His primary responsibility is support software for STSC's products for the IBM PC and compatible machines.



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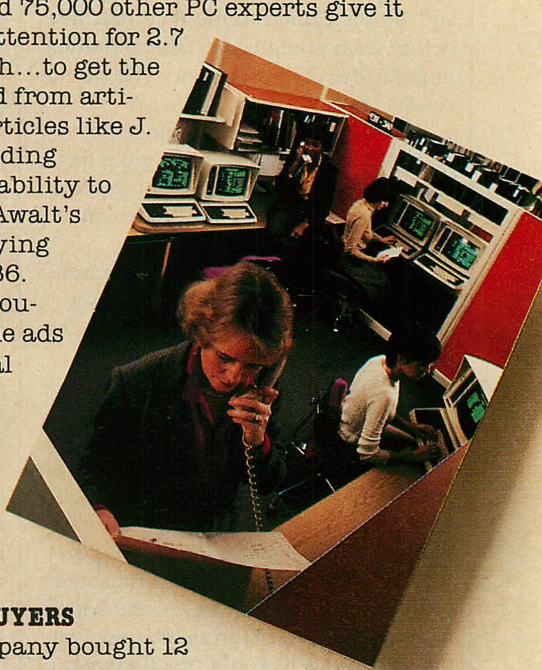

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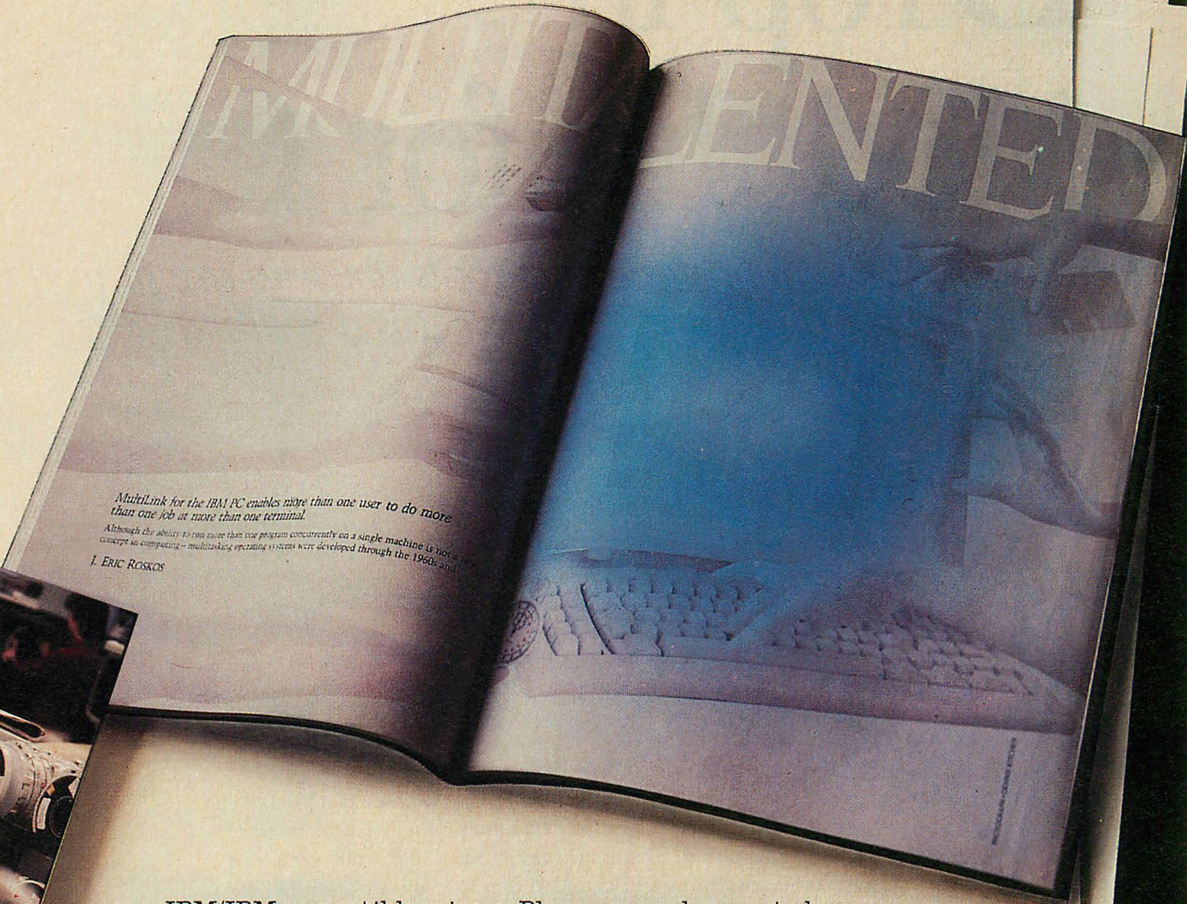

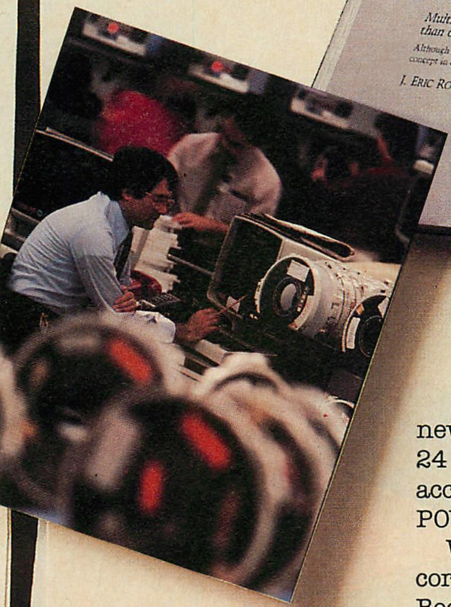

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Drop-in Modules for C

Most of these general-purpose tools libraries are flawed in some way; only Blaise Computing's C Tools 2 is a real winner.

WILLIAM J. HUNT

This is the first article in a series on tools libraries for the C language. In the July issue, part 2 will review libraries for windowing in C.

For a programmer with a project to complete, time and technical skills are critical resources. Delays in finishing software mean lost revenues and lost opportunities. A development team without the proper technical knowledge jeopardizes the quality of a product and its timely completion.

Tools libraries can reduce the amount of technical skill and programming time required for programming projects. The economics of using software-tools libraries are simple and attractive. The cost of hiring a programmer (salary plus overhead) is $20 to $50 per hour for most companies, and technical consultants charge $35 to $50 an hour. A cost of $100 to $500 for a tools library is justified by a net savings of a few hours or days. Thus, buying a useful tools library has obvious benefits.

In evaluating tools libraries, a consistent point of view and some good criteria are needed. The following general criteria were applied here:

- Is the library easy to get up and running? Can the programmer learn how to use it quickly, too?
- Are the library's functions implemented well enough to be a part of the programmer's product?
- Does the library do enough to be of

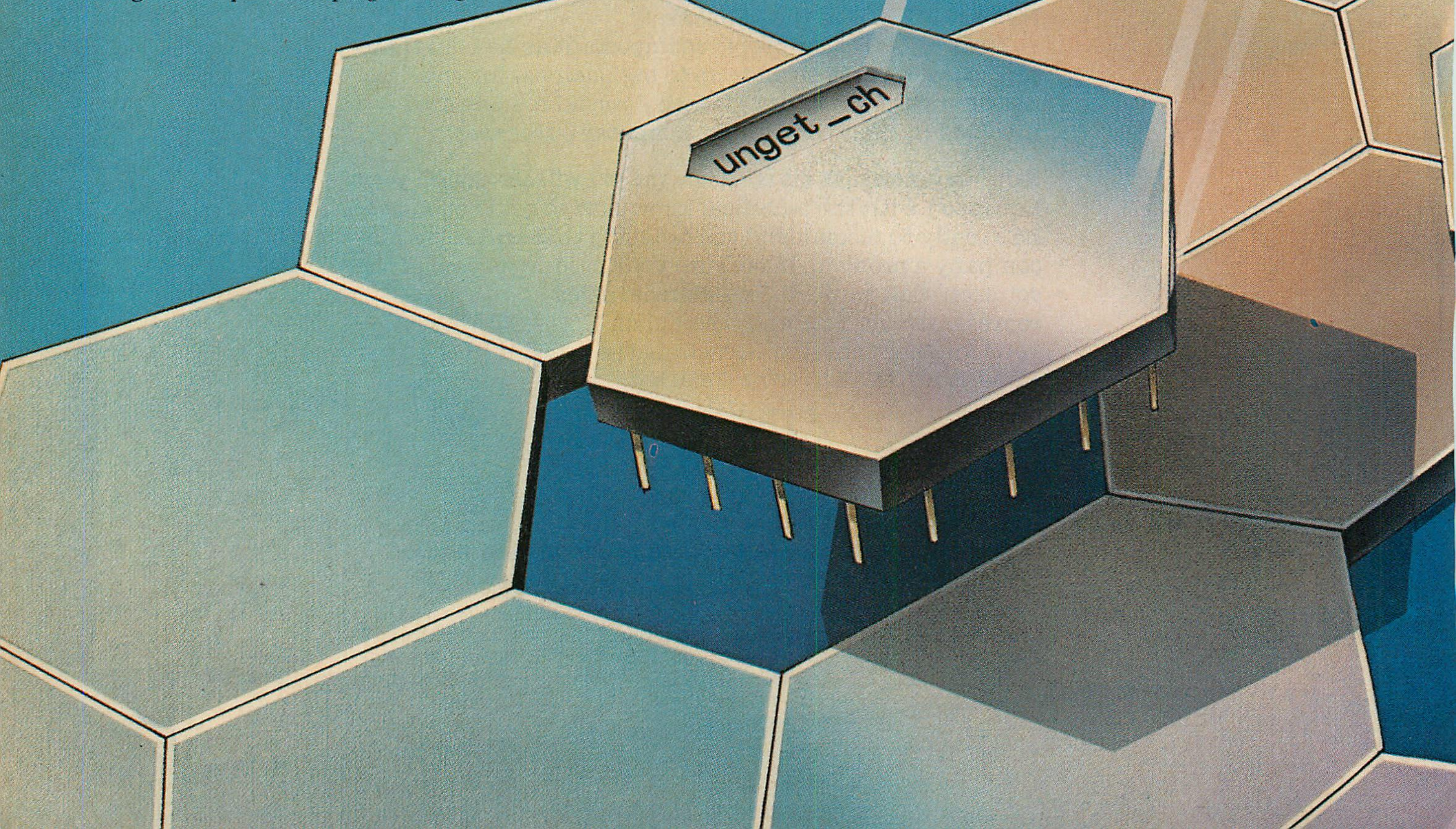

ILLUSTRATION • ANDY ZITO

real value to the programmer?

- Does the library lower the need for technical expertise? (What the library does is important, but so is the documentation to make it usable.)

Several kinds of tools libraries are available, including libraries that provide extensive support for a single part of the application. This article examines general-purpose libraries that provide more modest support in several areas. Only products that work with C compilers in the PC-DOS environment will be reviewed. Because C is a popular development language on the IBM PC, a number of tools libraries are available for it. C's open structure makes such libraries easy to integrate with programs.

The eight packages reviewed here are the C-Food Smorgasbord, Blaise Computing's C Tools 2 and C Tools, the Greenleaf Functions library, Essential Software's C Utility Library, Software Horizons' Building Blocks I, the XOR Corporation's C TOOLS, and Software Labs' C Utilities.

These packages vary in the functions they provide and in how useful they are. The C-Food Smorgasbord, the first tools library for C compilers, now needs some updating to meet the competition. The Greenleaf Functions library provides the largest number of functions. The C Utility Library also provides quantity in functions, but with variation in quality. The Building Blocks I library has some well-implemented functions, but its puzzling manual and nonstandard naming scheme make it difficult to use. XOR's CTOOLS library would be a modest success, although its manual is difficult to read. The Software Labs C Utilities supports game programs with animation and background sound functions. The Blaise C Tools and C Tools 2 libraries are complete products; the library functions are accompanied by documentation that makes them useful. Table 1 lists the products' features.

The table also lists the compilers that each library product supports. An entry for Microsoft C means that the library supports version 2.04 or earlier of Microsoft C, which is closely related to Lattice C. Microsoft is due to start selling a new compiler that will require different versions of tools libraries. Before buying a tools library, programmers using Microsoft C should check with the maker of that library to be sure that the library will be compatible with the version of C they are using.

Some products provide source code for some or all of the library functions. The source code helps the programmer understand how functions are implemented and makes it possible for him to modify functions that do not meet his needs exactly.

Most C compilers supported by these libraries allow a choice of memory models. Mark Williams' C and Computer Innovations' C86 provide a small model (64KB of code and 64KB of data) and a large model (1MB of code and 1MB of data.) Lattice C and Microsoft C provide these models and two others. A tools library should provide ready-to-use libraries for at least the small- and large-memory models.

Table 1 describes the relative extent to which each product provides the capabilities discussed in this article. Ratings describe whether a product provides few, some, or full capabilities in each area. In some cases, the rating describes specific capabilities, such as dot or line drawing for screen graphics or BIOS-based functions for asynchronous communications.

None of the products requires a runtime royalty; programmers may use library functions in a product they sell without having to pay a fee to the library's author for each copy.

It is impractical to report on test results for all features in these libraries, but programs representative of each

TABLE 1: *Product Features*

	C-FOOD SMORGASBORD	BLAISE C TOOLS 2	BLAISE C TOOLS	GREENLEAF	C UTILITY LIBRARY	XOR C TOOLS	BB I	C UTILITIES
PRICE	$150	$100	$125	$185	$149	$99.95	$149	$119
VERSION TESTED	2.13	2.0	2.0	2.10	1.1E	2	—	2.0
COMPILER USED	Lattice	Lattice	Lattice	Lattice	Lattice	CI-C86	Lattice	Lattice
COMPILER SUPPORTED								
Lattice	yes	yes	yes	yes	yes	—	yes	yes
Microsoft	yes	yes	yes	yes	yes	—	yes	yes
Comp. Innov.	—	yes	yes	yes	yes	yes	yes	—
Mark Williams	—	—	—	yes	yes	—	—	—
DeSmet	—	—	—	yes	yes	—	yes	—
OTHER LANGUAGES SUPPORTED								Pascal, FORTRAN
SOURCE CODE INCLUDED	no	yes	yes	yes	yes	yes	yes	part
SUPPORT FOR ALL MEMORY MODELS	yes	yes	yes	see text	small & lg.	yes	small	small
FUNCTIONS PROVIDED								
DOS calls	few	most	—	most	most	few	most	few
Directory scan supported	yes	yes	no	yes	yes	no	yes	no
Execute DOS command supported	no	yes	no	no	yes	see text	yes	no
Keyboard input	full	—	full	full	full	full	full	some
Text output	basic BIOS	—	basic BIOS	full	full	most	most	most
Graphics	dot	—	dot & line	dot & box	full	full	dot & line	full
Async commun.	full	—	BIOS only	full	BIOS only	—	most	most
PRINTER								
I/O	full	—	BIOS	full	BIOS	—	most	most
Mode control	—	—	—	full	full	—	—	some
Dot graphics	—	—	—	some	—	—	—	—
SOUND	—	—	full	—	full	full	—	full
STRING	—	—	full	full	some	—	full	—
OTHER								
Date conv.	—	—	—	few	few	—	most	—
Random no. generator	—	—	one	two	one	one	—	—

The top part of this table compares the general characteristics of the C libraries reviewed; the bottom half reviews their relative capabilities in each area.

TABLE 2: *Benchmark Results*

	C FOOD SMORGASBORD	BLAISE C TOOLS 2	BLAISE C TOOLS	GREENLEAF	C UTILITY LIBRARY	XOR C TOOLS	BB 1	C UTILITIES
SCREEN OUTPUT								
Char	2.1	—	2.8	1.9	4.2/1.1*	2.2	2.3	1.3
String (secs/1,000 chars)	2.1	—	2.8	1.9	4.2/0.9*	2.1	0.4	1.0
SCREEN GRAPHICS								
Write dot	0.43	—	0.66	0.44	0.19	0.82	0.54	0.53
Write line (secs/1,000 dots)	—	—	0.78	—	0.16	0.30	0.75	0.40
STRING SEARCH								
Sub-string	—	—	9.18	5.22	4.82	—	3.08	—
Single char (secs/1,000 searches)	—	—	2.36	2.09	4.95	—	1.81	—
FILE COPY								
Floppy disk	—	5	—	5	5	—	see	—
RAM disk (secs for 30,001 chars)	—	1	—	1	1	—	text	—

**The second set of numbers is the benchmark result for a new version of C Utility Library.*

As this table shows, some of the library packages reviewed here did not provide the functions that were required to run each of the benchmarks.

area of function were tested. A check was made to see whether a library supports the functions needed for each example and whether it implements functions correctly. Where appropriate, the performance of the test programs as they were implemented with each library's functions was tested. Table 2 reports results of the benchmark tests.

Writing characters and strings to the screen is one good test. Interactive programs need to display characters rapidly and to control the display attribute (normal, bright, underlined, or reverse video). They also need to be able to adjust the cursor position at will. The benchmark measures the speed of two *basic* functions—one that outputs a single character and an attribute and a second that outputs a character string with a specified attribute.

Listings 1 through 3 show the benchmark program as written for the Blaise C Tools package. The main function in listing 1 times single character and string output. Two loops repeat the operations enough times to give reliable timings (200 iterations and 20 characters per iteration were used). Positioning the cursor is also part of the test. Functions for setting the screen's mode and for generating a sound were included in the test program.

The main function in listing 1 calls functions **wca** and **wsa** to output single characters and strings. The Blaise C Tools package does not provide functions that write a single character or string and then advance the cursor. Listing 2 shows how **wca** and **wsa** were implemented in using functions **scattrib** and **scttywrt** from the C Tools library. When a library provided equivalents to **wca** and **wsa**, the program in listing 1 was modified to call these functions directly. Some libraries provided a function for single-character output but none for string output; in that case, the main program and the **wsa** function were modified to call the library's function in place of **wca**.

Listing 3 is a function that measures elapsed time. It uses a ROM BIOS call that returns the time of day in ticks of 18.2 per second. The version shown uses the Lattice C library function **int86** to generate a software interrupt. The Computer Innovations C86 version of **timer** used **sysint** instead.

Writing dots and lines on the screen also demands good performance. Listing 4 shows part of the benchmark program for this area; the rest of the program is the same as in listing 1. Tests were run with 200 iterations and 100 dots per iteration. Times required to draw 1,000 dots are reported; remember that in the 320-by-200 medium-resolution graphics mode the screen has 64,000 addressable dots.

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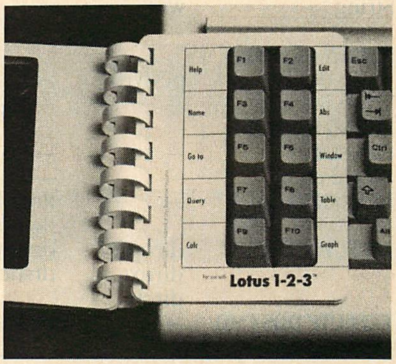

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TABLE 3: *Functions Used in Benchmarks*

	C-FOOD SMORGASBORD	BLAISE C TOOLS 2	BLAISE C TOOLS	GREENLEAF	C UTILITY LIBRARY	XOR C TOOLS	BB 1	C UTILITIES
SCREEN OUTPUT								
Char	pcvwca pcvwrt	— —	scattrib scttywrt	putinc	colrprtc	color printa	CrtSetAttr CrtCh	putchar2
String	wsa	—	wsa	wsa	colrprts	color print	CrtSetSttr CrtDsp	putlstr
SCREEN GRAPHICS								
Write dot	pcvwrd	—	grptwrt	wrdot	dot	point	CrtWrDot	writedot
Write line	—	—	grline	—	grline	line	CrtLn	drawline
STRING SEARCH								
Sub-string	—	—	stsindex	strfind	strindex	—	Indx	—
Single char	—	—	stschind	strcfind	strchind	—	Indx	—
FILE COPY	—	flread flwrite	—	dos2read dos2write	readfil writefil	—	see text	—
DIRECTORY SCAN	diropn dirnxt dircls	drsfirst drsnext	—	dosfirst dosnext	findfrst findnext	—	flfind	—
EXECUTE DOS CMD	—	pcdoscmd	—	—	doscmd	see text	SyDos	—

Several packages lacked functions for writing a single character and advancing the cursor. The function **wca** was implemented for this purpose. **wsa** calls **wca** and provides a write string with attribute function.

String-searching is the subject of the third benchmark program. It performs two searches: first it searches a string for the first occurrence of a specified substring, then it searches for a single character. Listing 5 shows the key part of the program. The substring "01xyz" and the character "x" were searched for in the string

"01234567890123456789012345678901234567890xyz"

Testfile.c, the program in listing 6, measures the speed of file I/O functions in copying a file. Table 2 gives results for copying a 30,001-byte file using an 8,192-byte buffer for both floppy disk and RAM disk files.

Listings 7 and 8 respectively are programs to scan a file directory and to execute a DOS command respectively from within a C program. Performance is not an issue for these functions, so table 2 simply shows whether or not a library supported the function.

Table 3 lists the functions used in the benchmarks for each library. As previously mentioned, the **wsa** function was used when a library did not provide a suitable function for string output. All tests were run on an IBM PC with an IBM Color Graphics Adapter. The **config.sys** file specified 12 buffers. Benchmarks were run with Lattice C version 2.14 or version 2.20J of Computer Innovations C86 for the XOR library. The small-memory model was used for all benchmarks, but operation of the test programs was also checked with the large-memory model when the tools library supported it.

C-FOOD SMORGASBORD

This product, sold by both Lifeboat Associates and Lattice, Inc., is an old-timer. Its packaging has been refurbished; but its contents also need upgrading.

C-Food comes in an IBM-style slip case and binder. The manual is typeset, but only 50 pages long. A single distribution disk contains libraries for Lattice C's four memory models, header files, and a few examples. Source code is not included but is available from Lattice for an additional $500.

Installation is straightforward. The manual gives adequate one-page discussions of the libraries included. Topic sections precede descriptions of individual functions. The organization of the manual is good, but key information about using the functions is omitted.

The manual contains few good examples. The distribution disk contains two sample programs, but they are large and hard to follow. It was necessary to run experiments to understand how to use C-Food's features.

C-Food was tested with version 2.0 of Lattice C. Several test programs worked, but errors occurred at the link step with two programs. Lifeboat's technical-support personnel quickly identified the old version of Lattice C as the problem and offered to arrange an upgrade. Additional advice was offered on using Lattice and C-Food. Lifeboat's support was quite good, but the manual should have identified the potential problem immediately.

C-Food provides basic support for BIOS screen and keyboard functions. The results in table 2 for screen output are satisfactory for BIOS-based functions. C-Food also provides a BIOS-based function to write a dot, but it provides no functions for drawing lines or other figures. The library offers a few CP/M-style functions for console, asynchronous, and printer I/O but no DOS 2.0 functions for file I/O or housekeeping. The directory-scanning functions in C-Food worked correctly in the **trydir** test program.

Floating-decimal arithmetic is one feature unique to C-Food. Decimal arithmetic gives rounding and truncation results that people expect—no problems with 9.9999 instead of 10.0000. Benchmark programs point out another advantage to the floating-decimal package: where C's binary float is two to three times faster for arithmetic operations, decimal float is ten times as fast for converting to ASCII characters and displaying (such as in **printf**.)

C-Food's decimal arithmetic may be useful, but it is not easy to use. The manual provides little guidance and the **calc.c** sample program is not much help either. The example below shows

that using the decimal arithmetic functions turns a program into a mass of function calls.

C FLOAT	C-FOOD FLOAT
x=a+b*c ;	fdmul (temp,b,c) ;
	fdadd (x,temp,a) ;

The Terminal Independence Package (TIP) is another feature unique to C-Food. A library of console I/O functions supplements C functions such as **getchar**, **putchar**, and **puts**. This library recognizes character values from 0 x 80 up as special control codes and translates them into escape sequences appropriate to a specific ASCII terminal. A disk file defines escape sequences for a number of terminals so that an application can select the proper escape sequences when it is executed. Most MS-DOS systems use a standard memory-mapped display adapter, but the TIP package can be used to write programs for systems that use ASCII terminals.

TIP was tested with the screen-output benchmark in listing 1. The result was the same as using the BIOS-based screen-output functions in the C Food library. TIP was not tested with a real terminal, but ran successfully with the ANSI.SYS driver when it was described to TIP as a DEC VT-100 terminal.

Because C-Food comes from the makers of Lattice C, it is natural to expect a first-class product. C-Food does not meet those expectations fully. It provides limited access to DOS functions, its skimpy documentation makes using the package unnecessarily difficult, and it does not include source code. Programmers who need decimal arithmetic or the terminal independence package and who can afford the time to learn to use the features C-Food provides will find the product worthwhile, but as a general-purpose DOS/BIOS library it falls short.

BLAISE COMPUTING C TOOLS 2

The C Tools 2 package is a rare animal—a product with documentation that is as well designed and tested as the software itself. A lot of effort went into making this product usable. The package covers only one area—using DOS services—but in that area it delivers real value.

Two disks include libraries for all four Lattice C memory models and source code for the library functions. The same disks include libraries for the Computer Innovations C86 compiler (small- and large-memory models). Header files for each category of functions define constants and data structures and declare all library functions.

Documentation is the strongest feature of the C Tools 2 package. The manual is thorough and well organized. Functions are listed in the table of contents with a short description. Each category of functions is introduced by a general discussion, followed by detailed descriptions of each function. These descriptions include good examples of using the programs. An introductory chapter describes what is in the product and how to use it. An appendix at the end provides more information about laying out the library on floppy and hard disk systems and about changing and recompiling the source files.

The library covers some tough areas: executing a program or DOS command from a C program, writing an interupt service routine in C, and scanning DOS directories are examples. The manual provides substantial information about what the library functions do and what the programmer needs to know to use the programs. It helps educate the programmer to use the library intelligently and to understand how the functions are implemented.

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The discussions are long, on occasion, and could use illustrations. The section on DOS memory allocation functions does not discuss the relation of these functions to the C library memory management services. Overall, however, the C Tools 2 manual is well ahead of the others.

The manual also lists interesting sample programs. The Zap program scans a tree-structured directory, deleting files that match a specification. Another program, Clock, installs a C function as an interrupt service routine to display the current time on the screen. These sample programs provide effective examples to supplement the manual's documentation.

The library does not cover string handling, screen output, or graphics output. It does cover DOS 2.x file I/O, directory access, and the execution of DOS commands; the benchmark programs for these areas worked properly. Finding and using the appropriate functions was easy using the manual.

C Tools 2 provides one capability not provided in any other product—it can install a C function as an interrupt handler. A tricky area; however, the manual and the Clock program provide the information a programmer needs to use the capability.

The source code is cleanly written. Each function is preceded by a comment describing its use. The comments roughly duplicate the manual's descriptions of the functions.

A good tools library can educate the user in its specific area. A programmer needs some information to make intelligent use of a library's functions, but a good manual and good source code can teach him how DOS or interrupt handlers work so that he can modify the library's functions or write his own. The Blaise C Tools 2 and C Tools packages are the only products reviewed that are potential educators for the programmer.

The C Tools 2 package does what a good tools library should do: it provides quality functions supported by the documentation needed to make those functions useful. For programmers who need the DOS access functions it provides, C Tools 2 is a fine choice.

BLAISE COMPUTING C TOOLS

The C Tools package shares some of the virtues of C Tools 2 and complements it. It does not provide enough useful functions, however, and the performance of the functions it does include is not outstanding.

Libraries are provided for all memory models of the Lattice and Computer Innovations compilers on the distribution disks. Header files and full source code are also included on the disks. The files are ready for use when they are copied to a work disk.

The C Tools documentation is thorough and effective. The manual helps the programmer find and understand the use of the function he wants. Several sample programs are listed at the back of the manual and included on the distribution disks. They further illustrate the use of the library functions.

String-handling functions are included with the C Tools package. Some of the functions provide substring extraction and replacement similar to that provided by the string functions in BASIC. This is fairly successful, but no such library can duplicate the automatic storage allocation that BASIC provides. The library also provides several useful string-conversion functions.

Screen-handling functions provide access to BIOS video I/O functions. With the exception of functions to display messages on the screen and erase

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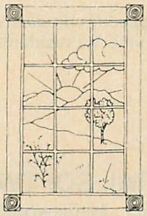

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them, C Tools does not build on BIOS screen services; it merely provides access to the BIOS functions.

Keyboard-input functions provide access to BIOS keyboard services—checking for and collecting keyboard input and checking keyboard shift status. Other functions use C library functions in order to display prompts and collect various types of data from the keyboard as responses.

Graphics functions are provided for drawing dots and lines; these functions are about average for those covered in this review. The package does not include functions for drawing circles or rectangles or for filling areas.

The benchmark results show that the C Tools functions are mediocre performers. Checking the source files shows that although most functions are cleanly written, they were not designed with fast execution in mind.

The C Tools library is well documented and easy to use. Its contents are a bit skimpy and the performance of its functions is rather lackluster. It is much less impressive than C Tools 2.

GREENLEAF FUNCTIONS

The Greenleaf Functions package is too much of a good thing. It provides lots of functions, but the documentation is inadequate, making it unnecessarily difficult to use the functions.

The trouble starts with installing the product. The manual does not provide complete installation information; it is up to the programmer to figure out what is on the disk and why it is there. Most files are stored in subdirectories, but the manual does not provide a road map. The Computer Innovations version includes libraries for small- and large-memory models, but the Lattice version includes only the small-memory model library. Using the large model (or either of the other two memory models that Lattice supports) requires that the whole library be recompiled.

DOS access functions, BIOS-based functions, and printer-control functions are included in the Greenleaf package. The DOS functions provide CP/M-style and DOS 2.0-style file I/O, directory scanning, and services to read and set the system date and time.

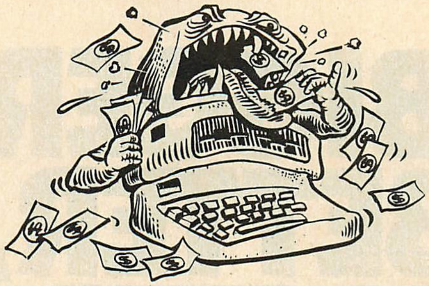
The manual provides a UNIX-style page for each function. These pages are adequate as descriptions of the individual functions, but finding and understanding a specific function is difficult.

No discussions of topics such as screen output or string handling are provided. The large number of functions makes it difficult to find any one. The manual provides no help in selecting from several functions that appear to do the same or similar jobs.

There are several header files to declare constants and data types that are needed when the library functions are used. Some of the data types and constants appear in examples in the manuals but without a reference to show where they are defined.

Most of the functions in the Greenleaf library are useful. However, the authors have inflated the number of functions by defining many when a single function would serve. For example, the library includes four functions for sending an ASCII control character to the printer and seven for sending control messages to the printer. One function for single characters and one for control messages would be better.

A pocket reference card lists functions by categories (DOS, video, printer control). It is a lifesaver—without it, finding the right function for the job would be nearly impossible. The reference card is a good idea, but better manual organization is preferable.



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Performance varies from good in the screen-output and file-copy benchmarks to average for the screen-graphics program. Source code was cleanly written with concern for performance. Individual assembly language functions handle most DOS and BIOS calls; these offer better performance than a general software interrupt function. However, the many assembly language functions are packed into a few source files, so a program using a few such functions pays a price of 3KB to 8KB in the size of the .EXE file. (The assembly language source files could be broken up to reduce the penalty, but the work involved would be substantial.)

One bad programming practice was evident. Greenleaf provides replacements for the **stdio.h** header file supplied with the compiler; it adds definitions of constants and macros for the library functions. Replacing the standard **stdio.h** header file is a bad idea: when the programmer upgrades to a later version of his compiler, the compiler vendor will probably change the **stdio.h** file. The programmer will have to examine the old and new versions of the vendor's **stdio.h**, compare them with the Greenleaf file, and make a new file that works. Greenleaf should have left the compiler vendor's **stdio.h** file alone and defined an additional header file under a different name.

The Greenleaf package provides some unique features—for example, DOS calls for reading and writing absolute sectors and functions for writing bit images (graphics mode) to an IBM/Epson printer. Two functions—**atget** and **atsay**—provide screen input and output similar to that in dBASE II. **Atsay** took only 5.5 seconds to output 1,000 characters in the screen-output benchmark.

The Greenleaf library has a lot to offer. It covers the same areas as the Blaise C Tools package with faster, more useful functions and offers some of the functions in the C Tools 2 package. But the overwhelming number of functions and a manual that does not adequately describe their use compromises the product. A diamond perhaps, but only in the rough.

C UTILITY LIBRARY

The instructions for C Utility Library did not provide a concise, step-by-step procedure for installation, but finding the key information was not too much trouble. Files are organized in subdirectories on the three distribution disks, which the manual made clear. The manual listed the contents of the source disk but not the other two. Overall, the package was simple to install.

The documentation for C Utility Library has some deficiencies. The manual does not provide enough help in selecting the right function or in understanding how functions are related. The table of contents does list functions alphabetically, and an appendix lists them by category, but the short sections on topics such as screen handling and graphic functions should be expanded.

Table 2 reports two sets of figures for the screen-output benchmark: one for the version reviewed here and one for a new version that arrived too late for a full review. The difference is dramatic and important: the old version is too slow to be useful, however the new version is genuinely good. Both versions use BIOS calls to write characters, but the new version uses direct, efficient assembly language functions to achieve maximum speed.

The graphics-output functions **dot** and **grline** are fast enough to be useful for applications in which high-speed screen graphics are not required. The library contains many other graphics

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functions as well—enough to implement bar charts and other graphs easily.

A bug in the substring search function **strindex** was discovered while running the string-search benchmarks. Correcting the bug was not easy, because the source code was written in an obscure way with no useful comments.

The library provides efficient access to DOS 2.0 file I/O functions, as the file-copy benchmark shows. The programs for directory scanning and DOS command execution also worked correctly. In general, the library provides access to DOS services for file maintenance and housekeeping.

Essential Software's ads list window management as a feature. That sounds great, but what the product actually delivers is modest: functions to save and restore rectangular areas of the screen. These functions work fast (0.3 second to save or restore the whole screen) and produce only a little snow on a color/graphics screen. Another function scrolls a screen area up or down (the BIOS provides this capability). These functions are quite useful (for implementing a pop-up help screen, for example), but calling them window management is deceptive.

The window save and restore functions bypass the BIOS functions and access the PC's display adapter memory directly for good performance. It would have been a good idea to use the same techniques for character- and string-output functions.

The quality of the source code is mixed: along with some well-commented, clear assembly language code there are some poorly described C functions written in an obscure style.

The object library file is large—136KB. Adding this library file to the editor, compiler, linker, standard library, and normal working space requires more on-line storage than two 360KB floppy disks provide. In a hard-disk environment, the size of the library causes no problems.

Overall, Essential Software's C Utility Library offers many capabilities for a reasonable price. Some functions are implemented well (dot and line graphics); others are not so well done. With stronger documentation and better function implementations, it would be a winner. At present it can be recommended only with some reservation.

BUILDING BLOCKS I

Using Software Horizons' Building Blocks I (BB I) is like diving for pearls: the diver has to work hard and pry open a lot of shells to get an occasional jewel. Before the library can be installed, the library file must be decompressed (6 minutes). To look at the source files, the programmer must run an archive program (45 minutes). Finally, to use the functions, he will have to read the manual, and that is when the trouble really begins.

The manual is really five separate manuals with five tables of contents. Within each manual, functions are grouped by categories that are obviously clear to the manual's author, but probably not to its readers. Some descriptions of individual functions are extensive and others are only two lines long. Topic sections discuss some overall concepts, but they fail to explain fully what the library functions really do. Effective examples also are sorely lacking in the manual.

Software Horizons claims that the BB I library supports all memory models offered by Lattice and the other C compilers. This version of the product includes only one object library—the user specifies which model it supports. (Version 5.4, which arrived too late for

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this review, includes ready-to-use libraries for small and large memory models.) The manual contained no information about using different memory models and offered only one example showing how to compile and link C programs using the library.

BB I provides a number of functions for keyboard input. In addition to simple DOS and BIOS-based functions for checking for and getting keyboard input, the library provides higher-level functions that provide a batch facility for replaying a canned script. These higher functions do not use the ASCII and scan code values returned by the BIOS; BB I has its own system. The discussion of keyboard input is extensive, but does not satisfactorily explain what the functions do or their relationships.

Screen-output and string-search results are good, as table 2 shows. The test for writing graphics output was only average in speed. Test programs for directory scanning and executing a DOS command worked properly.

The BB I library has a full set of file I/O functions, but they do not appear to be based on DOS 2.0 I/O calls. It is not clear how these functions are implemented or what advantages they offer over standard C library functions. The discussion of fixed-length record files versus variable-length record files and of sequential-access methods versus random-access methods seem unnecessary in the DOS environment. Were the authors asleep when UNIX (and now DOS) made such prehistoric mainframe concepts irrelevant?

Using the BB I library creates many unnecessary annoyances. Header files have names such as **Kbkeys.rpl** or **fil.def** instead of **kbkeys.h**, and function names contain a mixture of upper- and lowercase letters—**KbHit**, for example. Some screen-output functions use the standard BIOS attribute values, but others expect values for normal, reverse video, and underline attributes that are different from what the BIOS and the PC hardware expect. Even screen-cursor positions are redefined to start at 1 rather than at 0 as the BIOS software expects. Source files are poorly commented, and without a road map, tracing the implementation of a function through the many source files is a frustrating experience.

The BB I (or Power Pack 1, as some ads call it) library seems to have been developed in another environment and moved to the environment of C, DOS, and the IBM PC. It contains much material—some that is fast and useful and some that is just left over

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from that other environment. Its manual is not short or skimpy, but it certainly does not make the product easy to use.

XOR C TOOLS

Installing the XOR C TOOLS library was easy. The libraries and header files needed were identified by instructions in the manual and a one-sheet update. Libraries for both small- and large-memory models were provided, as was full source code. All files were stored ready for use: no unpacking or extracting from an archive is required.

This is not a bad product, but it could benefit from a face lift. It is packaged in the kind of plastic case that normally houses a game program. The manual is only five inches by seven inches and is printed in small type. Descriptions of individual functions are run together without white space or page breaks. Within each description, section names, such as name and synopsis, are in large capital letters, and the function names are in small lowercase letters. Finding the description of a particular function is extremely difficult.

The manual is organized by major categories. Each section begins with a general discussion followed by descriptions of individual functions in that category. The general discussions are useful, but some important information that is needed to coordinate use of several functions is buried in descriptions of individual functions.

The library implements character-output functions in a reasonable manner. (The color function can be used, for example, to set the current attribute and the **printa** and **print** functions to display single-character and string output.) It provides access to other BIOS screen-output functions, such as setting and sensing the video mode, scrolling, and setting the cursor position.

Single-dot output is rather slow, but line drawing is about average in speed. Special case functions for vertical and horizontal lines are provided, as is a function for drawing boxes.

String handling, file I/O, and directory scanning functions are not provided in the library. The XOR library does not provide a function to execute a DOS command, but it does provide a command to execute another program. The benchmark program in listing 8 was modified to verify that this library function worked properly.

The XOR C TOOLS library is sold for use with the Computer Innovations C-86 compiler. Although the manual does discuss converting the functions for use with other compilers, the discussion is brief and general. The effort and knowledge required make such a conversion unattractive.

This product provides competent BIOS-based keyboard input and screen output, but its unreadable manual makes using it too painful.

C UTILITIES

Although Software Labs' C Utilities has some redeeming features, its developers need to give it more attention.

The manual looks shoddy and seems out of date. The print quality is poor—the pages are blurry—and it is poorly organized. It has neither a table of contents nor a list of functions.

Installation instructions are short and incomplete: no mention is made of different memory models, for example. Functions are supplied as six object files; no library file is provided. The object files work with the small model of Lattice C. Source code is provided for some graphics functions but not for the majority of the functions in the product.

The package includes BIOS-based functions for keyboard input and screen output and a useful set of graphics functions (circles, ellipses, pies). Character-output performance is good for BIOS-based functions and average for dot- and line-drawing functions.

In addition to the usual sound function, which waits while the sound is played, music functions play simple tunes in the background while the program does something else.

Screen-animation functions let the programmer create and move rectangular blocks of dots on the screen. About one-fourth second is required to remove a quarter-screen-sized block from one spot and redraw it in another spot. A demo program shows that these functions are fast enough for animation.

For applications in which the music or animation features are important, this product may be worthwhile. As a general-purpose tools library, however, it is a poor value and a poor choice.

CHOOSING A PACKAGE

To choose one of these packages, the programmer must first identify the capabilities that are most important for his applications. Any of these libraries will require some investment of time.

Only two packages provide BIOS-based screen output fast enough to be useful. None made proper use of the 8088 block instructions for fast string-handling functions, and only one performed dot and line graphics at a useful speed. The documentation was a disappointment with most of the products.

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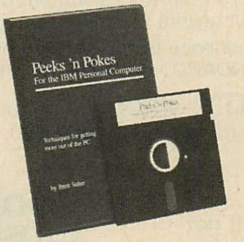

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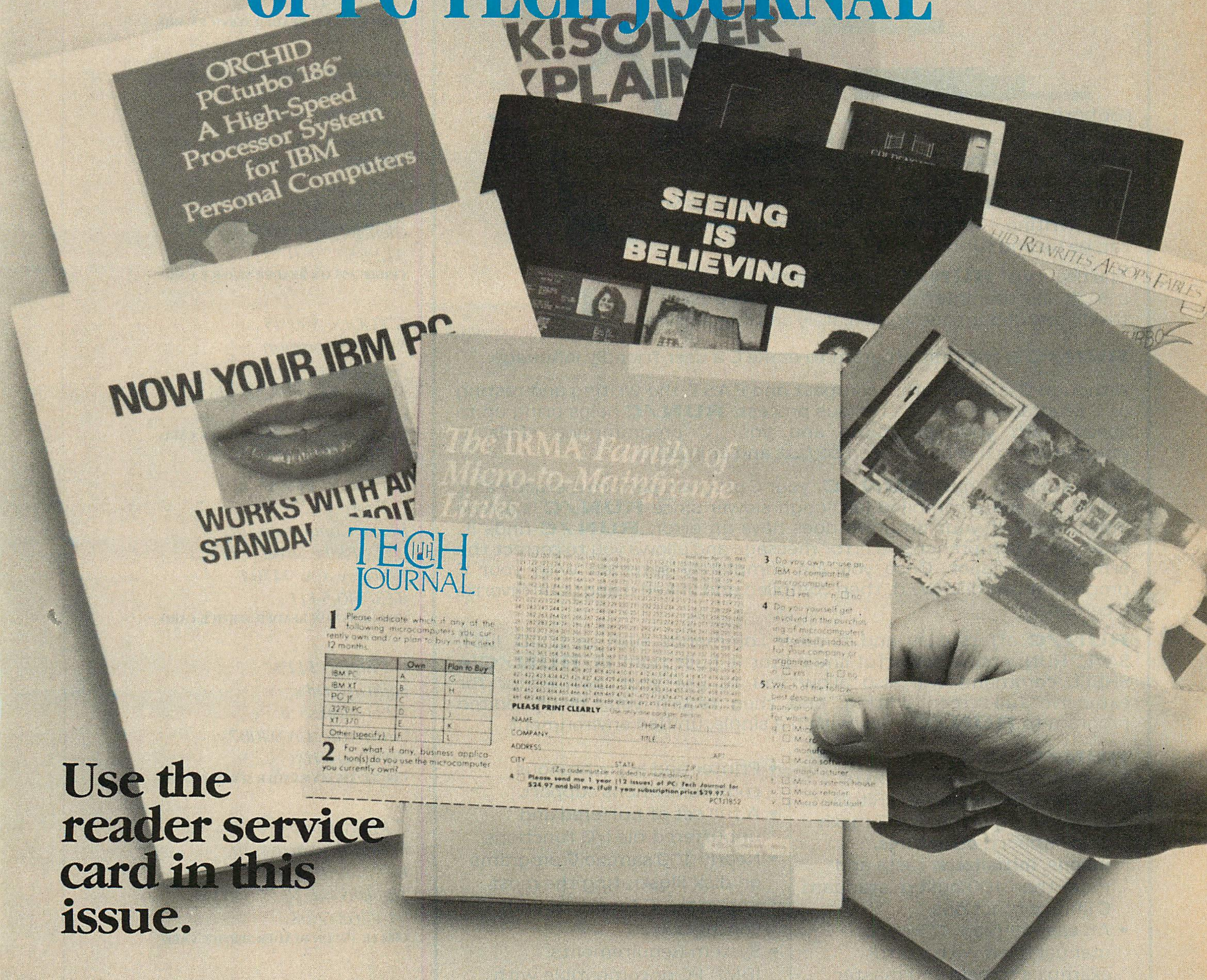

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provides good discussions of difficult topics, such as interrupt handlers and directory access. The Blaise C Tools package is also helpful when used in conjunction with C Tools 2; it covers the areas C Tools 2 omits.

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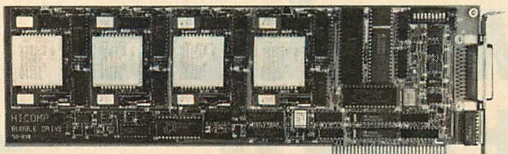

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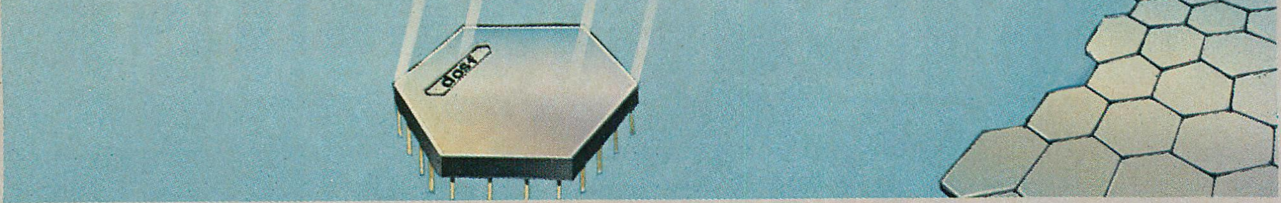

A good tools library can supplement C to provide access to PC-DOS, the PC's ROM BIOS, and the PC's hardware itself. The C language and its library provide no features to take full advantage of the capabilities of the IBM PC and its environment. C is not designed especially for the PC; it is effective on a variety of computers and operating systems. To develop a good product, however, programmers often need to use the unique features of the PC environment. Listed below are some of the capabilities a library might provide.

Access to DOS services. Applications programs often need to use PC-DOS features. For example, a well-designed application would get the current date and time from DOS rather than asking the user to type it. With full access to DOS's capabilities, the programmer can design applications to work well rather than to fit the limitations of C's standard library.

PC-DOS provides function calls for file I/O (create, open, read, write, seek, and close), file maintenance (setting a file's date and time stamp, renaming and deleting files), and directory creation and deletion. It provides general housekeeping calls (get and set the default drive, current directory, disk transfer area, and system date and time) and a call to return the operating system's version number. One call executes another program at the command of the program already running.

Keyboard input. Interactive applications need to check for the presence of keyboard input without waiting for input, to collect single keystrokes immediately without the return key being pressed, and to check the current state of the shift keys. In addition, keyboard-input functions should not filter out any control or function key inputs; nor should they allow DOS to act on keys such as Ctrl-C or Ctrl-P. The C library functions for console input do not meet these requirements, but a tools library can supply access to ROM BIOS services that meet these needs.

DOS also provides calls for keyboard input; because its services are more portable but less comprehensive, a complete library should give access to both DOS and BIOS keyboard functions.

Screen output (text). C's library functions for console output also lack some important features. Programs often need to sense and control the cursor position and to set the display attribute so that it corresponds to characters that are output. In addition, screen output speed is often unsatisfactory for C library functions.

The ROM BIOS provides functions to display characters with attributes and to return or set the cursor position. It also provides functions for sensing and setting the current video mode, setting the cursor shape, scrolling, and erasing part or all of the screen.

The performance of the BIOS screen functions is still marginal—tools-library functions should be carefully implemented to conserve the limited speed of BIOS screen output. It is even better if the tools library implements functions that write directly to the display adapter memory for really fast output.

Screen graphics. Unlike the IBM PC's BASIC, C provides no built-in functions for graphics. Providing the features and speed needed for heavy graphics applications is the province of libraries such as Halo and the Virtual Device Interface announced by IBM. It is reasonable, however, for a general-purpose tools library to provide simple functions for drawing dots, lines, circles, and boxes with enough speed for small applications. Although the ROM BIOS has calls for writing dots, these functions are too slow for serious use.

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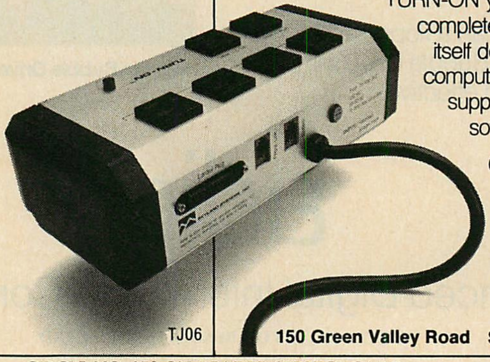

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Support for async communications. Both DOS and the BIOS provide some calls for I/O to the PC's RS-232 serial I/O ports. The unbuffered noninterrupt-driven support that these calls provide is adequate in only a few communications applications. Libraries that provide support for high-speed communications with buffered, interrupt-driven I/O will be reviewed in a later article.

Printer support. DOS and BIOS also provide calls for output to a printer via a parallel port. Functions to control printer features such as boldface or underlining modes may be useful. To be really useful, such functions should support a variety of printers and allow the choice of printer to be made when the applications program is executed. Several of the libraries provide functions to control an Epson or IBM printer. Although some discuss how to change the functions for other printers, all require that the selection of the type of printer be made at compilation.

Sound. The PC hardware provides crude mechanisms for controlling its speaker. Library functions to play a frequency for a specific duration and to turn the speaker on and off are included in some products.

In addition to the PC-specific functions discussed above, some other utility functions are often included in tools libraries:

String functions. C provides some support for character strings, but there is room for improvement. Functions that correspond to BASIC's string functions may be useful for BASIC programmers. Functions to search strings for substrings or for single characters are also useful. Functions to perform conversions or translations on strings may also be of value.

Date conversion. Arithmetic and format conversions are a necessary part of many commercial applications. Functions to convert the Julian calendar to month/day/year format are often useful. Functions to calculate the number of days between two dates and to determine the day of the week are possible library functions.

Random-number generation. Game software often requires random-number generation. C does not include a random-number generator, but several of the libraries reviewed here provide one or more functions for generating random numbers.

—WJH

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"Grep" looks for text patterns in any number of files. Its powerful expression syntax goes far beyond your text editor's search command. Use of "(.+)" with "*.c" will find in all files with ".c" extensions all lines with parenthesized expressions, no matter how many characters lie between. Want to find all function calls? Look for all occurrences of, say, a global variable throughout a program system? Search for all programs in a directory, use paths to other directories? Find all files on a disk? "Grep" will grab them all.

"WC" counts lines, words, and characters in a file and has a checksum independent of machine character sets so you can test whether a file has been transferred successfullybetween computers.

"Ed" is similar to the well-known Unix editor. It offers search and replace with "Grep's" syntax, block move, read and write, optional line numbering, append, insert, delete, and this unusual facility: you can instruct "Ed" to apply a file of commands to any number of target files, even complicated changes and text additions, such as those created by "Diff".

"Diff"? You've probably tried to write one (and then discovered how tangled the logic gets). "Diff" compares text files line for line and reports differences. It uses complex algorithms to re-synchronize between files after disparities involving any number of lines are found. And it outputs a precise list of instructions telling what to do to make two files exactly the same, a list which can be handed to "Ed" to do the job!

You'll ultimately find such assistance indispensible. Like having a librarian to sort out the confusion every day and keep your work tidy.

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CVUE

A Text Editor to Make Your Own

CVUE is a neat screen oriented text editor which does most of the things that a good editor should do, such as automatic scrolling vertically and horizontally, insertion and overtype entry modes, block delete, undelete and move, and full DOS 2.0 directory path name support in reading and writing files.

It is easy to learn with a comprehensive command menu screen which makes the documentation an ornament. It was written by the Lattice programmers who felt forgotten by the folks who write WP software. They needed easy entry of non-display characters such as control codes and escape sequences, not footnotes. Indenting and Undenting of block structures loomed larger than italic printing for them. Pattern searching won out over spell checking. So CVUE was born.

CVUE has its limitation. It only supports in-memory text files, but with memory at today's prices, creating and maintaining files of over 500 KBytes long is practical. Anyway, modular source code of structured programs never gets nearly that big. As compensation, CVUE is very compact and fast. It actually runs in computers with only 64 KBytes of memory and uses no tediously slow overlays to perform its full function repertoire.

The power of CVUE is its ease of customization. Even with only a binary license, full customization of the keyboard editing commands is offered. And when you take advantage of the Source Code option (found elsewhere in this ad.) the resultant editor can be made truly your own.

Product Code: L2240# Price: **$100**

CURSES

A Screen Management Interface to Swear By

Curses is a Lattice creation which manages the screen of the IBM PC in the same fashion as the curses utility of Unix and similar operating systems. Use it to adapt programs which call Unix's curses functions for screen management, and need the equivalent library when moved to the PC for re-compilation. Or use it when creating software on the PC to assure that it is Unix compatible.

Curses is a library of eighty-four functions and macros which can keep any number of screen images in memory.

Within a screen, Curses employs a vast function set to get characters, wrap lines, scroll, blank lines, highlight — virtually every tool needed to update the screen. The product supports color, and all four memory models. In keeping with the terminal orientation of Unix curses, the physical screen is re-painted (at high speed) only when your program calls a refresh function.

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Product Code: L0850# Price: **$125**

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The command file uses a simple, readable syntax — "prog.obj: prog.c $(HDRVS)", for example, says what source file this object file depends on, and fills the previously defined macro HDRVS into the expression, which here might be a list of files with hardware drivers, or in another case your preferred string of compiler options.

LMK does not care what programming language you use; it's not just for C. For that matter, LMK can apply to more than programming. It can be used for *any* set of tasks which can be accomplished through commands issued to the operating system. Try it for repeated re-assembly of lengthy documentation, or for *selective* re-consolidation of spreadsheets so that only dependents of changed supporting schedules get recalculated.

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CIRCLE NO. 102 ON READER SERVICE CARD

LISTING 1: char.c

```
/* char.c - char output benchmark for Blaise CTools package */
#include "stdio.h"
#include "screen.h"
#include "utility.h"

main()
 {
    int nit, nper, attr, mode, row, col, c, i,j,t ;
    float tf ;
    char s[200] ;

    printf("no.iter. no.chars/iter char  attr and mode : \n");
    scanf("%d %d %x %x %d",&nit,&nper,& c, &attr,&mode) ;

    screset(mode) ;              /* set mode */
    timer() ;                    /* start timer */
    for(i=0 ; i<nit ; i++)
      { sccurset(i % 16,0) ;     /* set cursor position */
        for( j=0 ; j<nper ; j++ )
          {  wca(c,attr) ; }     /* write the char */
      }
    t = timer() ;                /* collect elapsed time */
    tf = ( (float) t) / 18.2 ;
    sccurset(20,0) ;             /* set cursor position */
    printf(" %10.2f secs per 1000 chars \n",
      tf*1000.0 /(nit*nper) );

    utinkey() ;                  /* wait for a keystroke */
                                 /* now time string write */
    for( j=0 ; j<nper ; j++ )    /* build a string */
      { s[j] = (j & 0x3f) + 0x20 ; }
    s[j] = '\0' ;

    timer() ;                    /* start timer */
    for(i=0 ; i<nit ; i++)
      { sccurset(i % 16,0) ;     /* set cursor position */
        wsa(s,attr) ; /* write the string */
```


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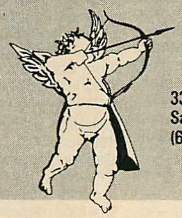

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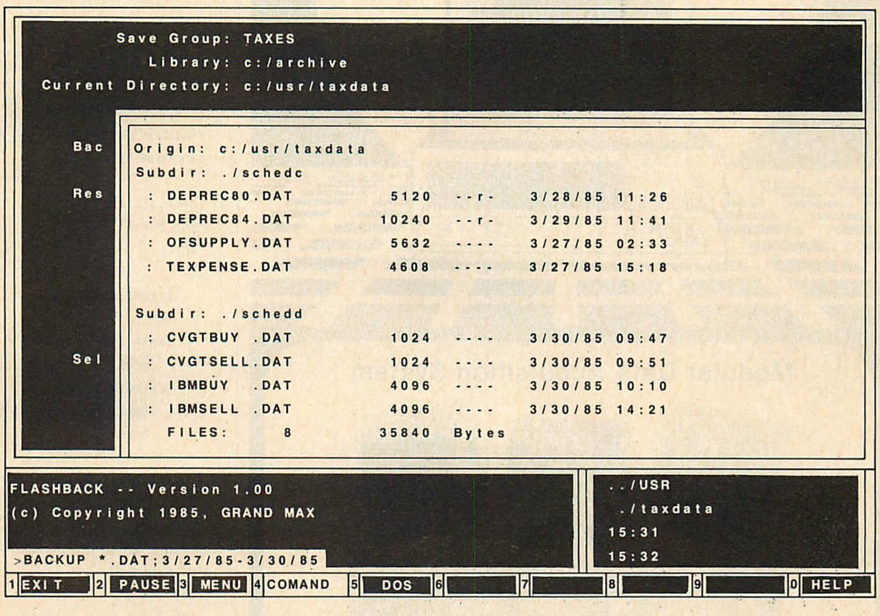

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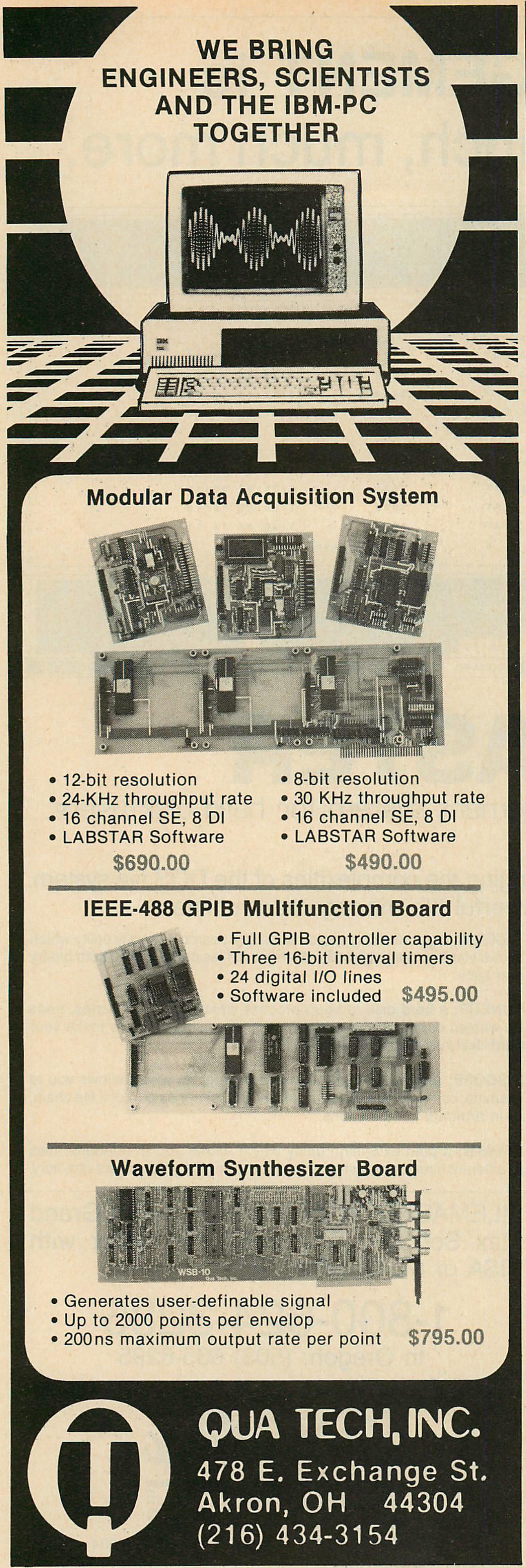

CIRCLE NO. 177 ON READER SERVICE CARD


```
      wsa(s,attr) ; /* write the string again */
    }
  t = timer() ;              /* collect elapsed time */
  tf = ( (float) t) / 18.2 ;
  sccurset(20,0) ;           /* set cursor position */
  printf(" %10.2f secs per 1000 chars \n",
      tf*500.0 /(nit*nper) );
}
```

LISTING 2: wca.c

```
/* wca.c - write char and string with attr.- Blaise Ctools */
#include "stdio.h"
#include "screen.h"

int wca(c,a)                    /* write char and attribute */
 int c ;                        /* char to write */
 int a ;                        /* attribute to write */
 {
   switch( c )
    {                           /* check for control chars */
     case '\r' : case '\n' : case 0x07 : case 0x08 :
       break ;
     default :
       scattrib(a,0,c,1) ;      /* Ctools function writes */
       break ;                  /* char and attr. to screen */
    }                           /* does not advance cursor */
   scttywrt(c,0) ;              /* Ctools function to write */
 }                              /* char only and move cursor */


int wsa(s,a)                    /* write string with attribute */
 char *s ;                      /* string pointer */
 int a ;                        /* attribute */
 {
   while( *s != '\0' )          /* repeat until end of string */
    { wca(*s,a) ;               /*    use wca to write next char */
      s = s + 1 ;               /*    advance pointer */
    }
 }
```

LISTING 3: timer.c

```
/* timer.c - use BIOS time-of-day interrupt */
#include "stdio.h"
#include "dos.h"

static long stime ;             /* time-of-day from last call*/
#define TOD_INT  0x1A           /* BIOS time-of-day interrupt*/

int timer()                     /* count elapsed time since */
 {                              /* last call (in ticks) */
   struct XREG sreg , dreg ;
   long etime , delta ;

   sreg.ax = 0 ;                /* operation = get time count */
   int86(TOD_INT,&sreg,&dreg);  /* do software interrupt */
                                /* assemble 32-bit TOD value */
   etime = ( ((long) dreg.cx) << 16 ) + dreg.dx ;
   delta = etime - stime ;
   if( (dreg.ax & 0xff) != 0)   /* new day since last call? */
      delta = delta + 0x01800B0L ;/* yes-add 1 day in ticks*/
   stime = etime ;              /* save TOD for next call */
   return( (int) delta ) ;      /* return as an integer */
 }
```

LISTING 4: dot.c

```
/* dot.c - dot graphics benchmark for Blaise Ctools package */
...
#include "graph.h"
...

   if( mode == 6 )
      grinit(2,0,0) ;           /* set mode */
   else grinit(1,1,0) ;
   timer() ;                    /* start timer */
   for(i=0 ; i<nit ; i++)
    { for( j=0 ; j<nper ; j++ )
```

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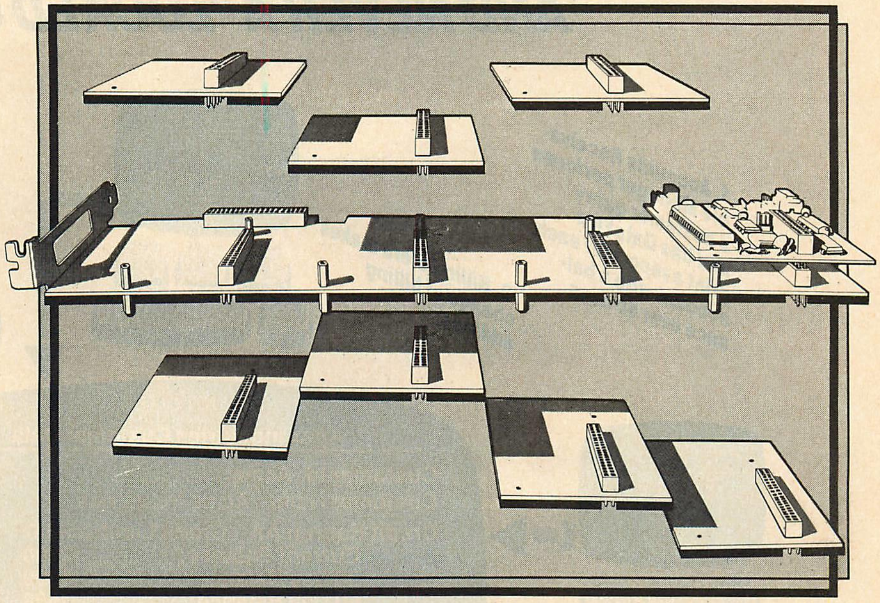

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- May be used with other Busboard products for high slot efficiency.

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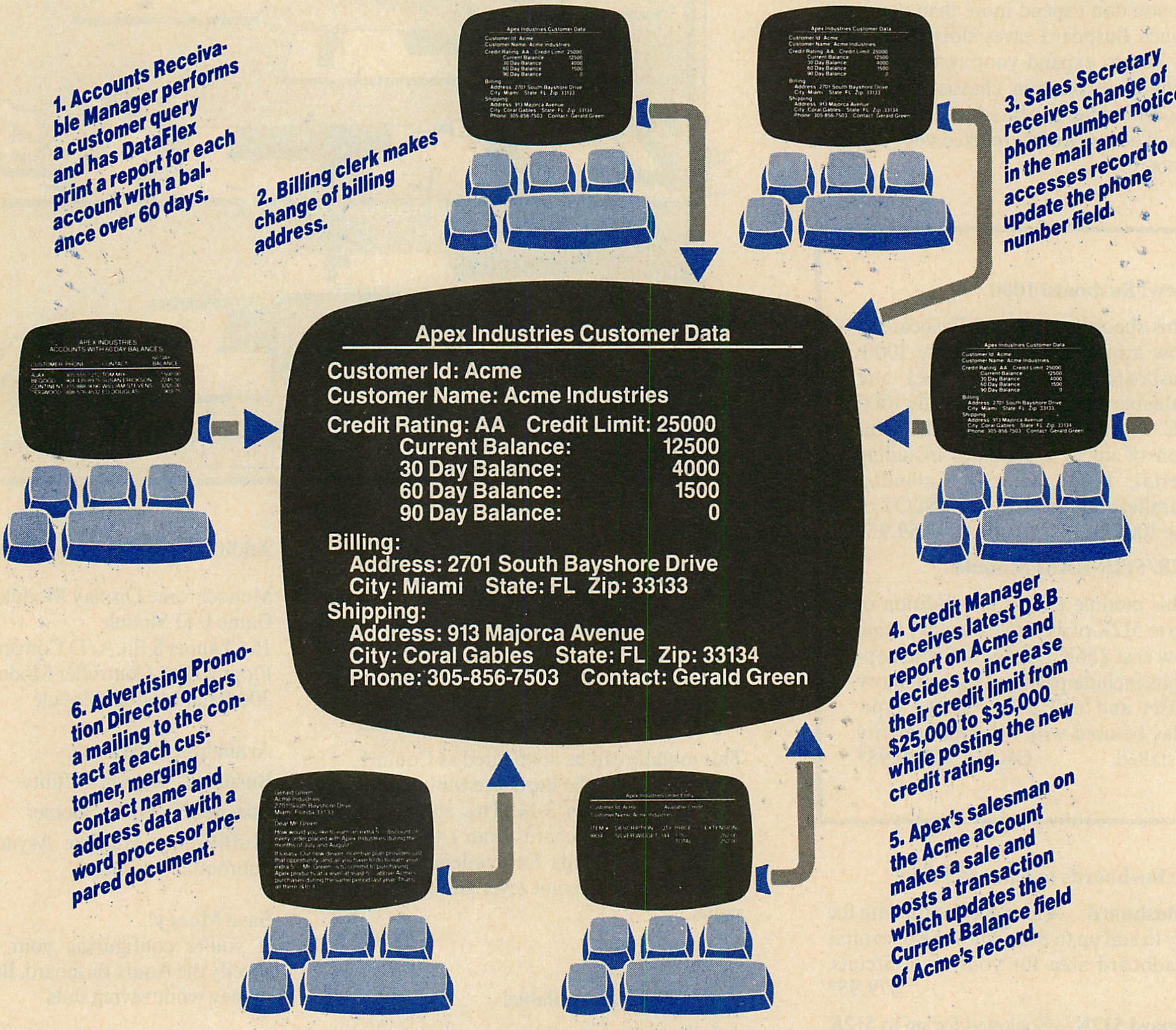

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CIRCLE NO. 132 ON READER SERVICE CARD

```
        { pos.y = i & 0x3f ;  /* row = 0 - 15 */
          pos.x = j & 0x7f ;  /* col = 0 - 63 */
          grptwrit(& pos,color) ; /* write the dot */
        }
    }
    t = timer() ;                  /* collect elapsed time */
...
    timer() ;                      /* start timer */
    for(i=0 ; i<nit ; i++)
      { pos.y = i & 0x3f ;         /* row = 0 - 15 */
        pos.x = (i+i) & 0x7f ;     /* col = 0 - 63 */
        pos2.y = pos.y + nper ;    /* end point */
        pos2.x = pos.x + nper ;
        grline(&pos,&pos2,color) ; /* write a 45 degree line */
      }
    t = timer() ;                  /* collect elapsed time */
...
```

LISTING 5: teststr.c

```
/* teststr.c - string function benchmark */
...
#include "screen.h"
#include "utility.h"
char s1[500] , s2[500] ;
...

    timer() ;                      /* start timer */
    for(i=0 ; i<nit ; i++)
      { for( j=0 ; j<nper ; j++ )
          {  ret = stsindex(s2,s1) ;} /*search for sub-string*/
      }
    t = timer() ;                  /* collect elapsed time */
...

    timer() ;                      /* start timer */
    for(i=0 ; i<nit ; i++)
      { for( j=0 ; j<nper ; j++ )
          {  ret = stschind(s2[0],s1) ; }  /* search for char*/
      }
    t = timer() ;
...
```

LISTING 6: testfile.c

```
/* testfile.c - file copy benchmark for Blaise Ctools2 */
#include "stdio.h"
#include "filehand.h"
                                  /* data type for 8088 address*/
typedef struct { int r ; int s ; } ADS ;
char buffer[16384] ;              /* I/O area */

main(argc,argv)
 int argc ;
 char *argv[] ;
 {
    int    in ,
           out ;
    long n ;
    int ercode , ercode2 ;
    unsigned nr , nw , c ;
    ADS bufads ;
    unsigned cs,ss,ds,es ;

    utsreg(&cs,&ss,&ds,&es) ;   /* build segmented address for*/
    bufads.r = (int) & buffer ; /* I/O area */
    bufads.s = (int) ds ;

    if( argc < 3 )
      { printf("\n no file names \n");
        exit(0);
      }
    printf("\n bytes to read \n");
```


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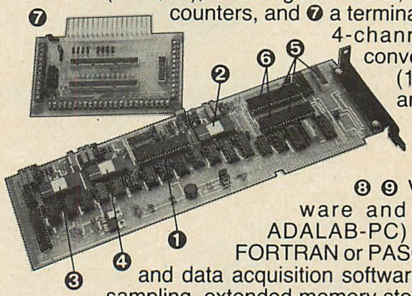

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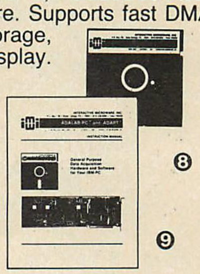

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Technical Bulletin
No. 2 in a series.

QNX™

SUBJECT: Engineering a LAN for Maximum Flexibility.

Quantum Software Systems Ltd. proudly announces QNX 2.0 — the Ultimate Distributed Network Operating System. QNX 2.0 is now available for the IBM-PC, IBM-AT, PC compatibles, DEC Rainbow and TANDY 2000. If you have been waiting for a Real-time Multi-tasking Multi-user Operating system with fourth generation LAN support, then QNX 2.0 can offer you today what the competition can't even begin to promise for the future.

QNX 2.0 integrates the Local Area Network architecture right into the heart of the operating system, at the fundamental level of intertask communication allowing tasks to communicate transparently with other tasks across the whole network. This means that any task (program/application) may access ANY serial port, ANY printer or ANY disk on the network. There are no artificial restricitons. Every PC with a disk is a potential file server. PCs without disks will automatically BOOT over the network.

QNX on the IBM-PC AT:

QNX is the first Multi-tasking Multi-user Operating system available for the AT. It is available in both networked and single machine configurations. At about 2.5 times faster than the QNX 8088 PC based systems, and 10 times faster than other multi-tasking operating systems on the same processor, QNX is the ideal program development environment.

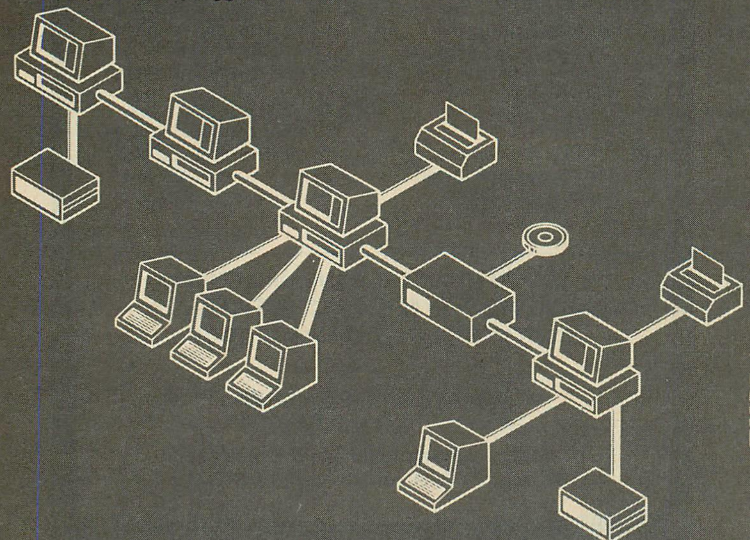
O/S	Computer	Processor	Measured time
QNX ™	IBM-PC AT	80286	480 usec
XENIX ™	Intel-286	80286	4,930 usec

File Security:

Designed with extensive file security features, QNX 2.0 provides login protection with network wide file permission checking based on 255 groups of 255 users. In addition, each PC user may control network access to devices attached locally to their machine.

Distributed Processing:

The QNX LAN supports distributed processing as well as distributed devices. Tasks may be executed on remote stations as easily as they may be executed on the local work station. This allows pure processing elements (PCs without keyboards or displays) to be plugged into the network to be used as an un-committed processing resource. This is ideal for real-time, process control, data acquisition and data communication applications.



Global Communications:

QNX supports a full implementation of X.25 allowing connection to public networks such as Telenet and Datapac. This allows you to link geographically separate LANs together providing true global area networking.

Cost Effective Growth and Flexible Solutions:

QNX is affordable, and will work with the PCs you use today and those you will use tomorrow. You may mix and match different brand PCs on the same QNX network with absolute ease. Multi-user expansion may be accomplished by adding terminals to PCs or PCs to the network. You can start your multi-user application on a single PC with 1 to 10 attached terminals. Once your single processor starts to show signs of degradation, add another PC and connect terminals to the new processor. If the disk becomes the major bottleneck, you may add hard disks to other attached PCs to distribute the processing. Applications which are very CPU intensive may wish to limit a single user to each processor and expand the system with low cost diskless PCs used as work stations. QNX does offer a truly cost effective and flexible solution to your applications needs.

Portability:

QNX 2.0 is portable. The operating system is independant of the physical local area network. It is available in a form suitable for porting to other 8088/8086/80186/80286 computers in the consumer, educational and industrial market place. QNX is ROMable and can operate in as little as 128Kb RAM.

DOS Compatibility:

PC-DOS version 2.1 can run as a task under the QNX 1.2 or 2.0 operating systems. QNX will also allow transparent access to the DOS file system partition and floppies.

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QNX Operating System	PC-DOS Emulator
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C Compiler & 8086 Assembler	Full Screen Menu Developer
Basic Compiler	Isam File Utility
Qbol (dibol) Compiler	Networking Board
Text Processor	OEM Customization Kit
Real Time Spelling Checker	(to port QNX)

Established:

Quantum sold over 10,000 copies of its operating system during 1984, into all business systems environments, to developers of real time applications, government and educational systems, to software developers/integrators, universities and research establishments.

QUANTUM SOFTWARE SYSTEMS LTD.

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CIRCLE NO. 239 ON READER SERVICE CARD

```
    scanf("%d",&nr);

    erconde = flopen(argv[1],&in,RDONLY); /* open files */
    ercode2 = flcreate(argv[2],&out,WRTONLY);
    if( (ercode != 0) || (ercode2 != 0) )
      { printf("can't open a file %d   %d",ercode,ercode2);
        exit(0) ;
      }
    n=0;
    ercode = flread(in,& bufads,nr,&c) ; /* 1st read */
    while( (ercode == 0) && (c > 0) ) /* repeat until EOF */
      { n=n+c ;
        ercode2 = flwrite(out,& bufads,c,&nw); /* write */
        if( (ercode2 != 0) || (nw != c) )
          { printf(" write error-code=%d nw=%u\n",ercode2,nw);
            break ;
          }
        ercode = flread(in,& bufads,nr,&c) ; /* read next */
      } ;
    printf("\n thru -   %ld chars\n",n);
    printf(" ercode = %d \n",ercode) ;
    ercode = flclose(in);
    ercode2 = flclose(out);
    printf("\n close error codes - %d %d\n",ercode,ercode2);
}
```

LISTING 7: trydir.c

```
/* trydir.c - try directory scan functions - Ctools2 */
#include "stdio.h"
#include "direct.h"
char spec[80] ;

main()
  {
    int ret , attr ;
    FSPEC dir ;

    printf(" spec and attr(Hex): \n");
    scanf("%s %x",spec,&attr) ;
    printf("\n\n");

    ret = drsfirst(spec,attr,&dir) ; /* get 1st file entry*/
    while( ret == 0 )           /* repeat til search fails */
      { printf(" %s    %8ld bytes    attr=%02x \n",
          dir.fname , dir.fsize , dir.fattr) ;
        ret = drsnext(&dir) ;   /* get next file entry */
      }
    printf("\n ret = %d \n",ret) ;
  }
```

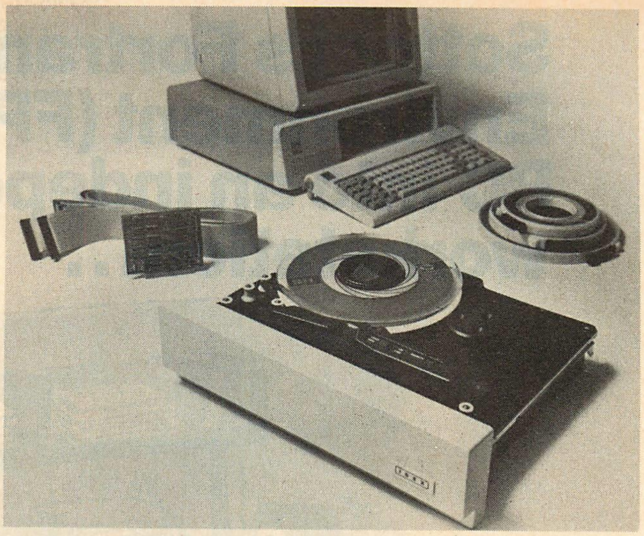
LISTING 8: trydoc.c

```
/* trydoc.c - try executing a DOS command - Ctools2 */
#include "stdio.h"

main()
  {
    char cmd[200] ;
    int ret ;

    printf(" enter a command : \n");
    gets(cmd) ;

    ret = pcdoscmd(cmd) ;       /* execute it */
    printf("\n\n ret = %d \n",ret) ;
  }
```

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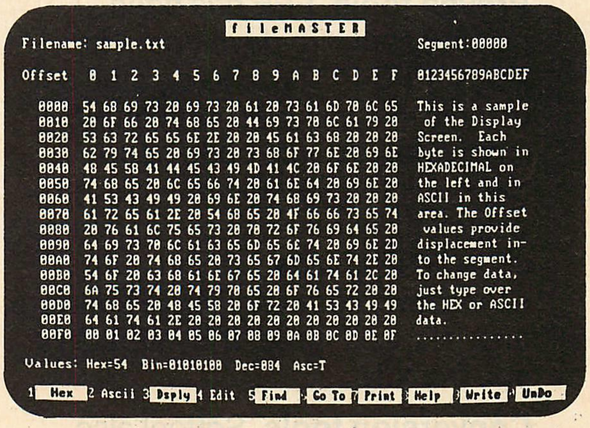

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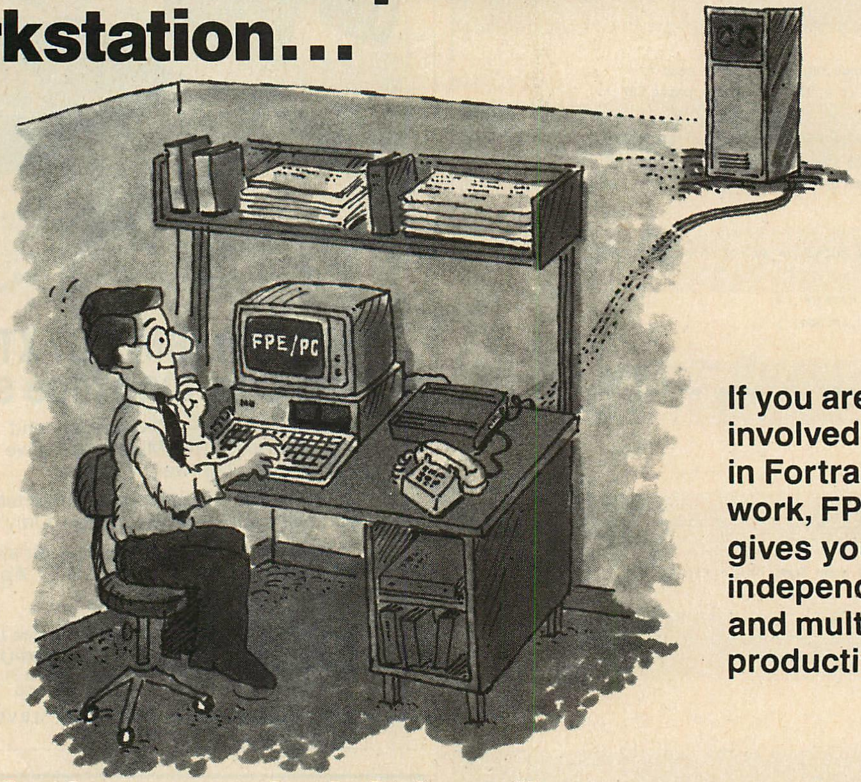

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CIRCLE NO. 242 ON READER SERVICE CARD

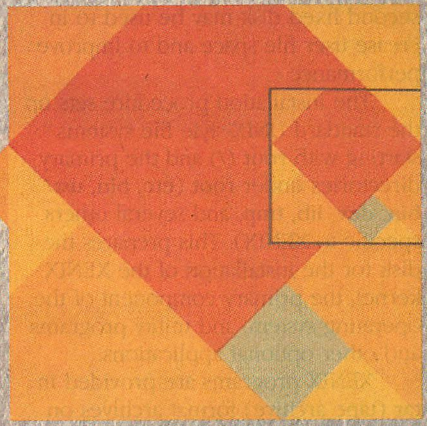
This dominant force in the microcomputer UNIX family clearly is a direct descendant of its minicomputer forebears.

XENIX for the XT

AUGIE HANSEN

The leader among microcomputer UNIX installations today is clearly the Microsoft-developed XENIX. Although estimates vary, Microsoft claims XENIX has 80 percent of the market. (XENIX and its five closest competitors were surveyed in "Reflections of UNIX," Augie Hansen, *PC Tech Journal*, May 1985, p. 54.) XENIX's domination is partly because it was an early entrant. Most microcomputer UNIX implementations are on 68000-based machines; UNIX has only recently emerged for the 8086 family. Equally important to its popularity are the useful additions to UNIX that give XENIX an aura of increased user-friendliness.

XENIX version 3.0, release 1.1, which is distributed and supported by The Santa Cruz Operation (SCO), is a port of AT&T System III UNIX to the Intel 8086/88 microprocessor. (A port by Microsoft to the IBM PC/AT will be reviewed in a future article.) In this review, an updated release of the development system (release 1.2) is described. This updated release uses Microsoft's CMERGE C compiler, which permits the development of programs under XENIX for both XENIX and MS/PC-DOS target systems.

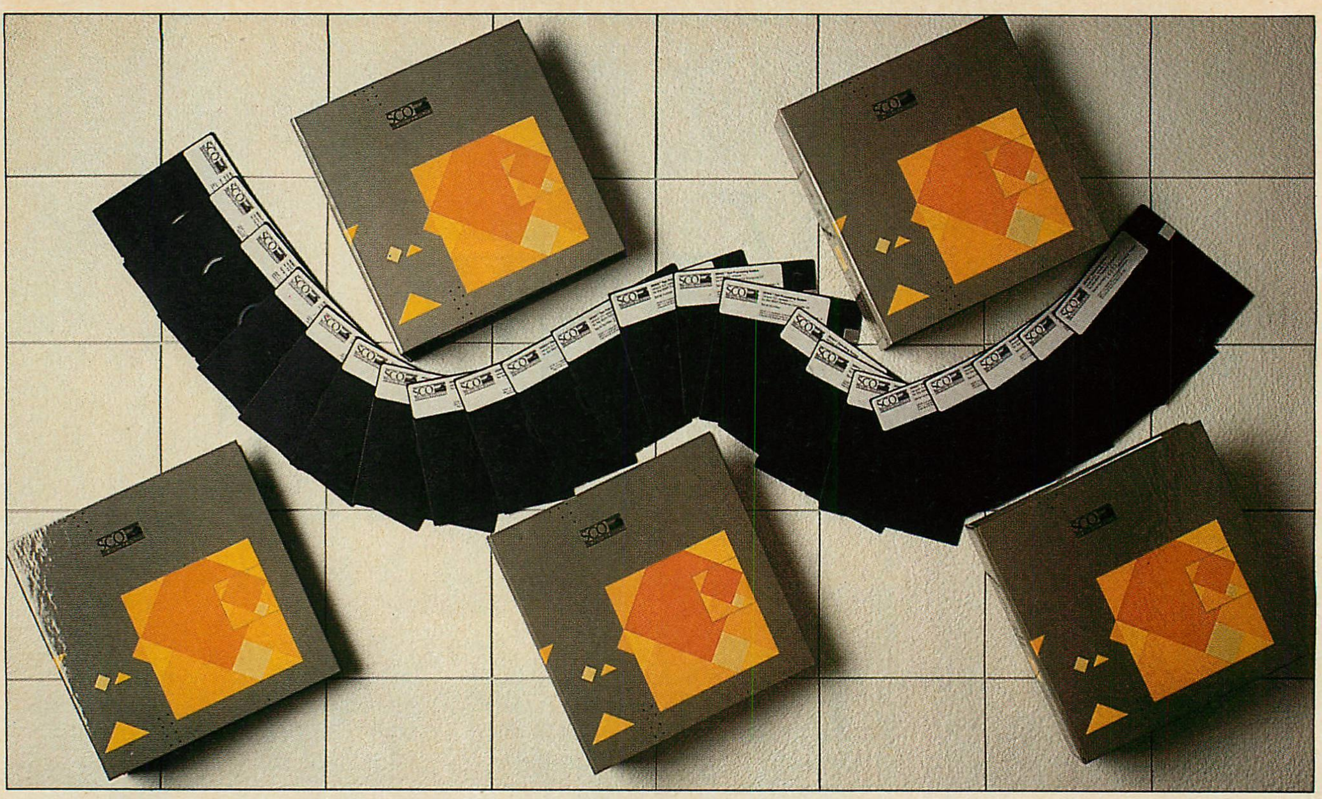


The relationship between UNIX (and XENIX) and DOS is a close one. Each new release of DOS has brought it closer in spirit to UNIX. The hierarchical file system, installable device drivers, and I/O redirection are but a few examples of the borrowed features. With the addition of cross-development tools, such as CMERGE, and DOS emulation capabilities, such as those provided by Uniform Systems' DOS Connector, UNIX and DOS are becoming more tightly entwined.

SCO XENIX is UNIX System III bolstered by some of the most popular Berkeley UNIX programs (**vi**, **more**, **csh**) and Microsoft's visual shell (**vsh**).

The unbundled system is sold in three major pieces:

1. Operating system (two installation diskettes plus nine system diskettes and two documentation binders). This is the minimum XENIX system, which provides all of the basic XENIX utilities, three user interfaces (shells), the **vi** text editor, and a full set of system administration tools.
2. Development system (seven diskettes and two documentation binders). This package includes language compilers, interpreters, and preprocessors (C, SNOBOL, cpp, m4), software engineering tools (make, SCCS), XENIX header files and libraries, and more. Release 1.2 includes the CMERGE C compiler and all the required DOS function libraries.
3. Text processing system (four diskettes and one documentation bin-



The Santa Cruz Operation's XENIX package is quite an impressive one. The operating system, development system, and text processing system total 22 diskettes and five attractive documentation binders. Price for the entire system is $1,350.

der). The **nroff** and **troff** programs and all their support programs and libraries are included. The package also has the **spell**, **style**, and **diction** programs and other tools for writing analysis and evaluation.

Each of the system packages is accompanied by a detailed set of release notes. SCO describes changes, limitations, and known bugs; a list of all the files provided on each distribution diskette is also supplied.

In addition, SCO offers a set of business applications to complement the standard offering. A full-featured word processor called Lyrix replaces the separate "edit and process" approach to document preparation that is traditional under UNIX.

Multiplan, Microsoft's respected planning and modeling package, is also available from SCO for XENIX users, as are the INFORMIX Relational Database System, several COBOL systems, and a variety of support tools for business applications development.

Product support for XENIX ranges from audio-visual, self-instruction tutorials and classroom training to customized end-user support programs. SCO's SoftCare service provides several levels of support on a fee basis. Also, XENIX system purchasers receive a 30-day, toll-free hot-line to assist them during installation and initial set-up.

Installation is painless. The installation instructions are detailed and clear, and the process is highly mechanized. A bootable XENIX image and a set of installation utilities are provided on two installation floppy diskettes. All the user has to do is answer a few questions and insert the diskettes in drive A: (sometimes referred to as drive 0) when instructed to do so.

Using the FDISK command, the user can create a partition for XENIX of 270 cylinders, reserving 35 for DOS or other uses. While running the installation procedure, I selected the default of 1,200 blocks (about 1.2MB) for swap space. Swap space is a portion of the hard disk that is reserved for saving halted or idle programs while other tasks are executing in main memory. A second fixed disk may be used to increase user file space and to improve performance.

The installation procedure sets up the standard UNIX-style file systems starting with **root** (/) and the primary directories under **root** (**etc**, **bin**, **usr/bin**, **dev**, **lib**, **tmp**, and several others specific to XENIX). This prepares the disk for the installation of the XENIX kernel, the primary component of the operating system, and utility programs and other optional applications.

XENIX programs are provided in **tar** (tape archive) format archives on nine diskettes. The **tar** program is called by an installation program that does all the work of copying the programs to their assigned locations in the XENIX file system. Error detection and recovery is excellent—the installation program recovered gracefully from attempts to foul it up by putting disks in the wrong drives. The basic XENIX system was installed in about 45 minutes, including time to read instructions, find the right disks, and double-check every step.

At this point I rebooted the system and put in a root (superuser) password to establish some system security. If the root password is forgotten, the entire system must be reinstalled. For security reasons, the root password may not be changed if the user does not know (or has forgotten) what it is.

The text processing system was installed in 6 minutes and the development system in 20 minutes. The installation procedure was as simple as typing "install" and inserting diskettes when prompted. At certain points in the process, XENIX runs **fixperms**, an installation program that sets the ownership and access permissions of installed files so that they can be read or executed, but not written to, by authorized users.

The process of installing users has been simplified from the standard UNIX method. A program called **mkuser**

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prompts the super-user (system administrator) for key information about the new user, such as log-in name, comments, work group, choice of user shell, and default password. The **mkuser** program updates the appropriate entries in the administration database files (**/etc/passwd** and **/etc/group**), creates a directory for the new user, and copies some start-up files to that directory. It also sends a test mailing to the new user containing a greeting—an electronic equivalent to the "welcome wagon."

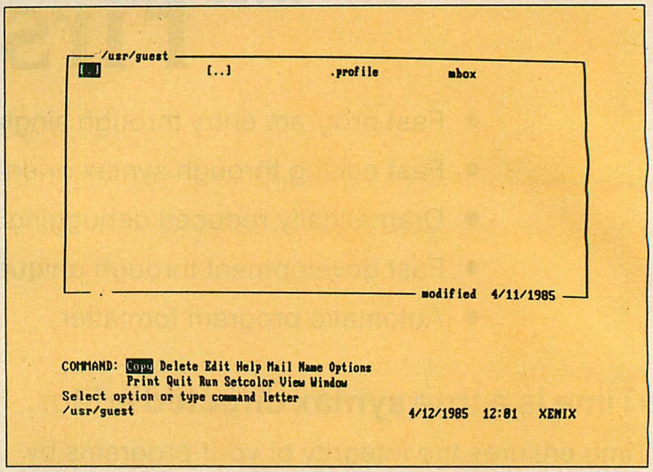
XENIX, as supplied for the IBM PC family, can be run without change on many compatible machines, including the AT&T PC 6300, Columbia 1600-4, Compaq PLUS, Eagle Turbo, and other systems equipped with a 10MB hard disk. At present SCO supports the addition of the IOMEGA Bernoulli Box and Tallgrass external disks. The drivers are available for $150 each.

Most multifunction cards can be used to expand the memory available to XENIX up to 640KB. XENIX must have at least 256KB of RAM to run. If main memory is less than 384KB, a small XENIX kernel may be installed. Although the small kernel has some limitations, such as reduced internal buffering and support of fewer simultaneous processes, in most respects it operates as the full-size kernel does.

Additional memory and some other features of multifunction cards by AST, Quadram, Sigma, Microsoft, and Tecmar can be taken advantage of with the appropriate switch and jumper settings for use of the serial ports with XENIX.

Only one parallel printer port can be used, because only one interrupt vector is available. XENIX can use an 8087 numeric data processor if one is installed in the system.

PHOTO 1: *The Visual Shell*



Besides the Bourne shell (sh) and the Berkeley C shell (csh), XENIX offers the visual shell (vsh), which provides a simplified, yet flexible, menu interface for nontechnical users.

USER INTERFACES

XENIX is equipped with three user interfaces, or shells, as they are generally known. The standard-issue Bourne shell (**sh**) is the default log-in shell. It is the same shell as is distributed with AT&T UNIX and provides the greatest degree of portability to most shell scripts.

The Berkeley C shell (**csh**), which has a syntax that is more like the C language, is a popular alternative. Among the features it includes are its command history mechanism, command *aliasing* feature, the **noclobber** option that prevents unwanted overwriting of files, and **ignoreof**, which makes it impossible to log off accidentally.

An attractive option to many first-time users and nonprogrammers is the visual shell (**vsh**), shown in photo 1, which simplifies the user interface while providing a reasonable degree of flexibility. It is based on the same menu interface provided with Microsoft's Multiplan and Word. Mouse pointing is not yet supported but keyboard arrow cursor movement is.

Vsh can be a bit slow and cumbersome to use, especially for programmers who prefer a command interface. **Vsh** uses much of the computing resource and memory—100KB memory compared to about 54KB for **csh** and 31KB for **sh**. The visual shell also has some inconsistencies in the way it operates. In some cases help is obtained by typing Alt-h and in others by typing "?".

The memory limitations of an XT may require all users in multiuser situations to use the same shell to avoid having several shells in memory and to reduce the need to have user processes "swapped out" frequently.

SCO XENIX has a feature called MULTISCREEN, which is a multiple virtual terminal capability. It allows the system console to have up to ten separate interfaces running concurrently. Only one virtual terminal may be used at any time (screen and keyboard), but

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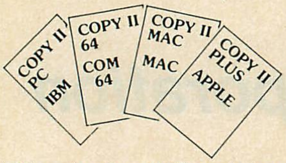

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TABLE 1: *DOS/XENIX Interface Commands*

COMMAND	DESCRIPTION
doscat [−r] file	Read each file in sequence and write to standard output
doscp [−r] file1 file2	Make a copy of file1 in file2
doscp [−r] files(s) directory	Copy file(s) into specified directory
dosdir name(s)	Emulate a DOS directory listing for each named file and directory
dosls name(s)	Same as XENIX **ls** command (without options), but for a DOS diskette
dosmkdir directory	Make a DOS directory (DOS 2.x only)
dosrm file(s)	Remove file(s) from a DOS diskette
dosrmdir directory	Remove a DOS directory (DOS 2.x only)
dtype [−s] device	Determine diskette type (meaning format—DOS, tar, cpio, etc.). The −s option shuts off the standard output so shell scripts can use only the return code

The −r argument may be used to override the default conversion of CR/LF to NL (or the reverse) that takes place when files are copied from DOS to XENIX (or XENIX to DOS).

These XENIX commands are provided to allow access to files on DOS format diskettes. Utilities are available that create and delete DOS directories, list directory entries, concatenate and copy files, and determine diskette format.

output directed to any of the virtual terminals is handled in the associated screen buffers. Tasks running on a virtual terminal are not suspended when the operator switches to a different virtual terminal. The MULTISCREEN feature was added by the Santa Cruz Operation. It is not available on other versions of XENIX.

The primary console is associated with the special device file **/etc/console**. The virtual terminals are associated with the special files **/dev/tty02** through **/dev/tty10**. Messages from the XENIX kernel—the ones that usually mean trouble—are displayed on the console screen. If one of the virtual terminals is active at such a time, the system switches to the main console screen to make the kernel message visible.

For external access, XENIX allows two serial ports to be used in either of two configurations. Each port may be run with or without modem control; modem control is not needed on local direct hook-ups or for outgoing **uucp** traffic, but is required for dial-in and most dial-out applications. The **enable** program is used to allow log-ins on a specified port or virtual terminal and **disable** does the reverse.

The **enable** program is actually a link to **disable.** It determines what to do by examining the name used to call it. For a hardwired connection on the first serial port, the command is **enable tty11**. To enable its use with modem control, the command is **enable tty13**. The **tty12** and **tty14** files in /dev control the second (auxiliary) serial port.

During testing, when the first serial port was used for dial-up access and the second was hardwired via a null modem cable to an AT for use as a terminal, attempts to run **cu**, the "call UNIX" command, put the process into an endless loop. The port was not properly configured. In each case I was able to log in on another terminal or virtual terminal and kill the errant process. The system did not crash but the user would have trouble getting out of the mess. Once the port was properly configured, there were no more problems.

Three demonstration log-ins (**demo, cdemo, vdemo**) have been preconfigured by SCO. Each runs a different shell (**sh, csh,** and **vsh**, respectively), and no password is required. These make nice guest log-ins but create huge security holes. These demonstration log-ins should be removed from a XENIX system that contains any private information. If a guest account is needed, its use should be limited to the restricted shell (**rsh**) and it should be password-protected to minimize the likelihood of unauthorized access.

XENIX uses one or more mountable file systems. Unlike DOS, which needs to have the user tell it which physical drive contains the file of interest, XENIX uses built-in, modifiable tables to keep track of the mounted file systems that contain both system and user files and directories.

A directory is a file that contains a set of 16-byte entries, each containing an i-node number and a file name. The i-node number identifies a table that

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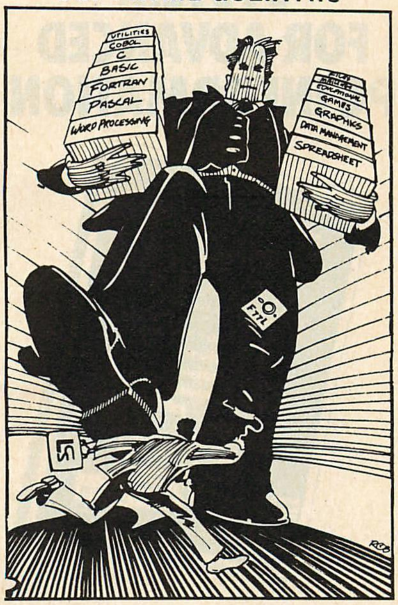

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TABLE 2: *Performance Summary*

C COMPILER: [1]			
Program size (bytes)	**SOURCE**	**OBJECT**	**EXECUTABLE**
empty	11	217	2,016
sieve	663	339	2,096
hello	77	265	4,160
Compile time (seconds)	**REAL**		
empty	0:49		
sieve	0:55		
hello	0:51		
Execution time (seconds)	**REAL**	**USER**	**SYSTEM**
empty	0.9	0.0	0.7
sieve	7.1	6.1	0.7
hello	1.1	0.0	0.8
MULTIPROCESSING TESTS: (minutes:seconds)			
Foreground sequential		**REAL**	
make sortdemo		2:15	
make xsort		1:20	
Total time		3:35	
Background/Foreground			
(make sortdemo; echo "\07") &		2:59	
make xsort		2:35	
Total time		2:59	
Background "Simultaneous"			
(make sortdemo; echo "\07 1") &		2:40	
(make xsort; echo "\07 2") &		2:51	
Total time		2:51	
PROGRAM LOADING: (seconds)[2]			
Vi editor	**FIRST INSTANCE**		**SECOND INSTANCE**
foreground only	0:12		0:04
background compile	0:30		0:19
"nice" background compile (lowest priority)	0:22		0:19

[1] *Using the CMERGE compiler producing XENIX small-model programs with optimization on (−0) and symbol table stripped (−s).*

[2] *Background compiles and first instance of vi run by root, and second instance of vi run by first user on alternate virtual console. The command "nice −20 ... &" runs the background compile at lowest priority (39).*

Tests except those noted were conducted with a user load of three, root being active and the two users idle. Root and the first user were logged in on console displays 0 and 1 respectively, and the second user was logged in on a dial-up line.

contains control information about one file. The i-node keeps track of the file's owner and group affiliation, protection level, times (creation, access, and modification), file size, and file type (ordinary, directory, or special).

The i-node also contains a block list, which is a set of pointers to blocks on disk that comprise the contents of the file. XENIX now uses a storage block size of 1,024 bytes, whereas earlier versions used the UNIX System III block size of 512 bytes. The new size is the same as that used by Berkeley UNIX and by more recent AT&T UNIX versions. The first 10 blocks are referenced directly. If a file needs more than 10 blocks, XENIX uses additional pointers in single, double, and possibly triple indirection to manage files more than a gigabyte in size on systems with suitable mass storage hardware.

The discrete file system arrangement has numerous benefits. A high degree of isolation prevents errors in one file system from corrupting the data in others. Yet, because the system knows the location of each mounted file system, it can access files within each file system by their path names regardless of the physical device locations. Individual file systems can be mounted easily,

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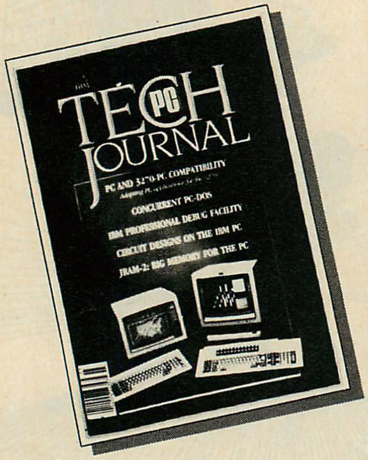

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which makes the subordinate files available to authorized users; they also can be unmounted, which prevents access to the files. The files remain on the disk, but are "out of service" until the file system is mounted again.

Most file systems will be on a hard disk for quick access. However, removable media, floppy diskettes for example, may also have file systems mounted on them. An empty directory under **root** called **/mnt** may be used to mount a temporary file system. To use a floppy diskette for some special need (partial back-up, transporting files to another system, etc.), a disk must first be formatted for XENIX, have a file system "made" on it, and then be mounted. This is described in chapter 4 of the *Xenix Installation Guide*.

PROGRAM DEVELOPMENT TOOLS

Release 1.2 of the development system has a replacement for the original C compiler. The new compiler is dubbed CMERGE because it has the ability to produce binary executable programs for both XENIX and DOS. This compiler can also produce 80286 binaries for use under DOS. A future update will produce XENIX binaries for the 80286 processor used in the AT.

The trick is to have independent sets of libraries and header files tailored to the different operating environments. A flag to the **cc** command, **-dos**, tells the preprocessor to use header files taken from the **/usr/include/dos** directory instead of the customary **/usr/include** directory. Similarly, linkable library functions come from a new place, **/usr/lib/dos**, instead of the **/usr/lib** directory. The DOS flag also causes the code generator to use the low-order word first for long variables in DOS programs. XENIX uses the opposite ordering for long integers (four bytes).

This version of the C compiler has some known bugs that are documented in the release notes. SCO promises fixes for these in future releases. A few bugs, such as an inability to cast functions to void (or typeless) and an error caused by a 16-bit, left-shift operation, will inconvenience some programmers, but they can be avoided.

The release 1.2 C compiler can produce programs in any of three memory models: small, middle, and large. Small is the default. In the small model, a program may be either pure text, with instructions and data in separate segments not to exceed 64KB each, or impure text, which intermingles instructions and data in one segment not to exceed 64KB.

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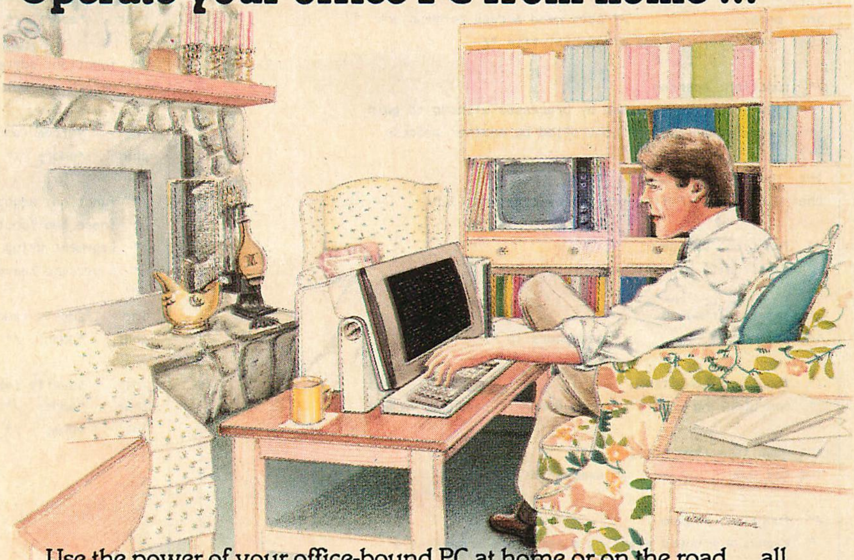

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FIGURE 1: *File/Record Locking*

```
#include <sys/locking.h>

locking (fildes, mode, size);

int             fildes, /* value returned by "open" call */
                mode;   /* type of lock operation

                        (0) LK_UNLCK    Release previously locked
                                        region.
                        (1) LK_LOCK     Lock a region - wait if a
                                        portion is already locked.
                        (2) LK_NBLCK    Lock a region - return error
                                        code if a portion is already
                                        locked.
                        (3) LK_RLCK     Lock a region - same as LK_LOCK
                                        but permit read-only to
                                        other processes.
                        (4) LK_NBRLCK   Lock a region - same as LK_NBLCK
                                        but permit read-only to
                                        other processes.
                        */
long            size;   /* bytes to be locked */
```

An extension to System III UNIX, file/record locking is provided in SCO XENIX as a C library function, locking any region of a file by one process; read access to the locked region may be granted to other processes, if desired.

FIGURE 2: *Semaphores*

```
/*  function: creatsem
 *  create a semaphore - this is done by a process that
 *  wishes to control a resource
 */
int  creatsem (sem_name, mode);
int  mode;              /* sets read access permissions  */
char *sem_name; /* name of special file */

/*  function: opensem
 *  open a semaphore - used by processes wishing to gain
 *  access to a resource controlled by another process
 */
int  opensem (sem_name);
char *sem_name; /* file created by creatsem () */

/*  function: waitsem
 *  wait - will block if resource in use
 */
waitsem (sem_num);
int sem_num;            /* semaphore ID */

/*  function: nbwaitsem
 *  non-blocking wait - returns error if resource in use
 */
int nbwaitsem (sem_num);
int sem_num;            /* semaphore ID */

/*  function: sigsem
 *  signal a process awaiting a semaphore - manages a
 *  FIFO queue of requesting processes
 */
sigsem (sem_num);
int sem_num;            /* semaphore ID */
```

Each semaphore used to handle synchronization of processes or resource sharing is given an ID by the **creatsem** and **opensem** functions. Processes waiting for a semaphore are held in a FIFO queue until the requested resource is available.

FIGURE 3: *Shared Data Segments*

```
#include <sd.h>

/*  function: sdget
 *  attach a shared data segment to the data space
 *  of the current process (size and mode used only when
 *  creating a new segment)
 */
char    *sdget (path, flags, [size, mode]);
char    *path;  /* name of a shared data segment */
int     flags;  /* ORing from these flags:

                Flag        Description
                ----------  ------------------------------
                SD_RDONLY   Attach to segment for reading only.
                SD_WRITE    Attach to segment for reading and
                            writing.
                SD_CREAT    No effect if path exists. Otherwise,
                            create a segment according to
                            size and mode values.
                SD_UNLOCK   Permits simultaneous access to the
                            segment by more than one process.
                SD_NOWAIT   Return an error upon a request for
                            a segment that is currently in
                            use and locked against
                            simultaneous access.
               */
long    size;   /* segment size in bytes */
int     mode;   /* read/write access permissions */

/*  function: sdenter
 *  indicates that the current process is about to access
 *  data in a shared data segment
 */
int     sdenter (addr, flags);
char    *addr;  /* pointer to shared data segment */
int     flags;  /* ORing of SD_NOWAIT and SD_WRITE above */

/*  function: sdleave
 *  indicates that current process is done accessing data
 *  in a shared data segment
 */
int     sdleave (addr);
char    *addr;  /* pointer to shared data segment */

/*  function: sdfree
 *  detach current from shared data segment at specified address
 */
int     sdfree (addr);
char    *addr;  /* pointer to shared data segment */

/*  function: sdgetv and sdwaitv
 *  these two functions synchronize access to a shared data
 *  segement using a version number that is changed each time
 *  a process leaves (sdleave) a segment
 */
int     sdgetv (addr);
char    *addr;  /* pointer to shared data segment */

int     sdwaitv (addr, vnum);
char    *addr;  /* pointer to shared data segment */
int     vnum;   /* version number */
```

XENIX permits shared data segments, allowing cooperating processes to access the same data area in memory. This sharing allows communications between tasks while avoiding the time-consuming use of pipes and temporary files.

If a program is likely to be used by several people at the same time (an editor is a good example), it should provide separate instruction (text) space. XENIX will keep in memory a single copy of the text that can be shared, eliminating duplication of instructions. Program loading times are reduced for all but the first user. This requires that the code be *reentrant*—that is, it must consist of pure procedures.

The middle model limits program data to 64KB, but the instruction space can be as large as memory will allow. Although large model programs (supported for DOS but not XENIX in this release) can have independent text and data of any size, no array or structure can be larger than 64KB.

The development system has a complete set of management tools, including **make** and the source code control system (SCCS). It also contains **lint**, the C language program checker; **adb**, a debugging program; and utilities to time, profile, and test programs in a variety of different ways.

ENHANCED FEATURES

As a means of circumventing what are perceived as major shortcomings of the UNIX operating system, XENIX employs a file-locking mechanism to block simultaneous access of a file or a portion of a file (one or more bytes) by more than one process; semaphores are provided as a means of providing interprocess communication and synchronization. In addition, XENIX permits the use of shared data segments, allowing cooperating processes to access the same data area in memory. This neatly avoids the more time-consuming use of pipes and temporary files in many situations.

The C compiler system has provisions in library routines for these features. Figures 1, 2, and 3 summarize the header files and routines for each of these features. Flag and mode values are defined in the header files that are included in programs using the file-locking and shared-data features. The figures show the C language syntax for each function. Descriptive information is provided within comment blocks.

The semaphore library functions use a unique ID for each semaphore. The IDs are returned by the **creatsem** and **opensem** functions and are used by the other functions to handle waiting and signaling operations for each access request on a given file.

In the realm of communications, XENIX offers Micnet, the Microsoft local area network, in addition to the standard **cu**, **uucp**, and **uux** commands that

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are the mainstays of UNIX communications. Local systems may be linked in serial- or star-network configurations and can be linked to remote networks transparently by **uucp**, permitting file transfers, electronic mail, and remote command execution using aliases for users. An alias is an easily remembered name that represents both a system (location) and a user name.

SCO also distributes uniPATH 3270 mainframe communications programs that allow XENIX systems to run processes that emulate 3274 cluster controllers for use with IBM mainframes. With appropriate display systems, terminals logged in to XENIX can work as 3278/79 block mode terminals with access both to the mainframe and to the local XENIX system.

Lyrix, a full-featured word processing program, is an option ($595) that should be considered by anyone who is a serious wordsmith. It takes the drudgery out of preparing everything from simple memos to large and complex manuscripts. Sophisticated formatting and printing options, file merges, and cut-and-paste operations are just a sampling of this powerful word processor's capabilities.

To give XENIX users access to DOS files on floppy diskettes, utilities are available that list directories, concatenate and copy files, and perform several other DOS functions. Diskette drives are declared in the file **/etc/default/msdos. A/dev/fd0, B/dev/fd1**, etc. are already set up. Table 1 summarizes these XENIX-DOS interface utility programs.

Users who have worked with UNIX will find XENIX to have a comfortable, familiar feel, but to be a bit slow.

All work reliably except one—unfortunately, that one is very critical.

The DOS copy program (**doscp**) is supposed to detect diskette formats for all versions of DOS through the 2.x series, but it does not work correctly. Files cannot be written to a properly formatted DOS 1.1 diskette for unknown reasons. When writing DOS 2.0 and later diskettes, the **doscp** command sometimes overwrites the format identification bytes at the beginning of the file allocation tables, preventing DOS from determining the format. That means DOS can neither read the directory nor find the files.

The files remain intact on the disk and can be recovered by using one of the many disk programs that permit reading and modifying DOS diskette sectors. Changing the first sequence of bytes in sectors 1 and 3 to FDFF (2 sides, 9 sectors/track) allowed DOS to read the file allocation table, directory, and files. Both copies of the FAT must be corrected in this way. SCO promises a fix for this in a later release.

PERFORMANCE

Users who have worked with UNIX will find XENIX to have a comfortable, familiar feel, but to be a bit slow. Comparing an 8088 micro to a VAX 11/780 super-mini is not entirely fair, of course. The system used in testing XENIX for this review was an original PC (64KB motherboard) that has been modified to XT compatibility ("The Making of an XT," Augie Hansen, *PC Tech Journal*, March 1985, p. 161). It has 576KB of RAM installed and reports 390KB RAM available to user programs after booting the XENIX kernel. The system has both color and monochrome display systems, two serial ports, and two 360KB floppy diskette drives in addition to a 10MB hard disk. It does not have an 8087. The clock/calendar on an Apparat CRAMBO multifunction board is not recognized by XENIX.

The most noticeable difference between XENIX on an XT and larger UNIX systems is the rapid decline in responsiveness as each new process is added. To quantify this performance degradation, tests were run in multiuser mode, but with only one user log-in active. This set-up accounts for the effects of context switching and other factors associated with multiuser operation, while reducing the risk of user-triggered asynchronous events clouding the results of the tests. System events were accommodated by averaging the results of a series of test runs.

Table 2 shows how the performance is affected when the load on the CPU is increased by adding more processes. The time it takes the system to respond to keystrokes and commands is what a user sees as system performance more directly than the amount of time it takes for a given task to run.

Response to user's keystrokes is quick under most loading conditions because XENIX treats user input as one of its highest priorities. However, within a program such as vi, response to user input can be degraded very noticeably, because the program itself is at a lower

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priority and does not echo as quickly. With a compile or an **nroff** job running in the background, XENIX can take more than 10 seconds to respond to a **vi** command or input string.

The CMERGE compiler does a very good job of optimizing programs for speed and small size. **Empty** is the minimum C source file; its 2,016-byte size is quite good as UNIX compilers go, reflecting a modest amount of overhead. Even the **printf** library function, used in the ever-popular "hello world" program, is compact. Some systems take about 6KB just for the **printf**. Here it is just slightly more than 2KB.

XENIX provides a small but noticeable reduction in elapsed time for a set of jobs to complete. Two small programs, **sortdemo** and **xsort**, were compiled in various combinations of foreground and background processing using the **make** utility. Savings of 36 seconds and 45 seconds were noted, averaged over three tests. The savings are attributable to several factors. With the background compiles, it is not necessary to load all of the compiler phases separately for each compile, and the disk arm scheduler can do some optimizations to reduce the amount of overall head movement. The real gain, if the system did not slow to a crawl, would be achieved by doing some other work in the foreground while the background jobs run independently.

Running a single compile or **nroff** job in the background dramatically. reduces the responsiveness of a system. A measure of this is the time that is needed to load the **vi** editor, a large program, under differing conditions. With no user background processes, **vi** loads, on the average, in about 12 seconds. Another instance of the program "loads" in approximately 4 seconds because XENIX permits shared program text (code). Therefore, the program code already exists in memory.

With a background task running at normal priority, as table 2 shows, XENIX takes considerable longer to load and run **vi**. Placing the background task (in this case a compile) at the lowest priority (39) eases the penalty somewhat. Normal priority under XENIX is 20. The super-user can run the priority of some tasks up to 0 for faster, though not realtime, performance.

On a system without memory protection, such as the IBM PC, users or the system cannot be completely protected from the errant behavior of other users' programs. When some C programs from various texts were keyed in, a few that were nominally "lint free" ac-

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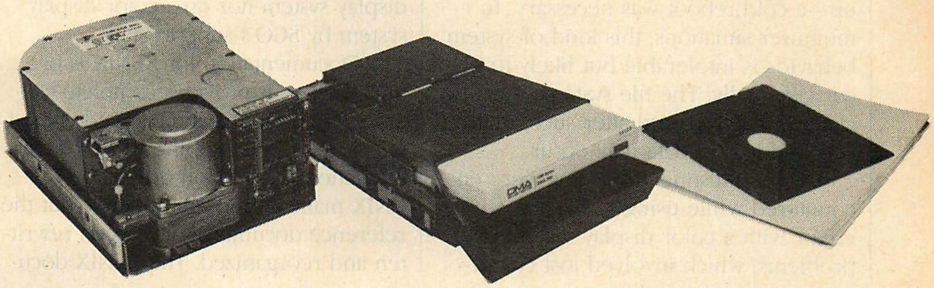

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tually had errors that got by the compiler and produced executable programs. When these programs were run, however, they caused the system to lock up—a cold reboot was necessary. In multiuser situations, this kind of system behavior is intolerable but likely to occur eventually. The file systems must be cleaned and repaired after such a failure, and loss of data may occur.

During testing, problems were encountered while using the **vi** screen editor with a color display system. The problems, which involved lost characters and stray commands during insert mode and some strange behavior of programs run in a subshell, could be duplicated neither with a monochrome display system nor on a color display system by SCO's support staff.

Documentation for XENIX is of high quality. It provides complete coverage in an understandable and consistent manner. Much of the XENIX documentation is based on original AT&T UNIX manuals and memoranda, but the reference documents have been rewritten and reorganized. The XENIX documents are fully indexed and provide meaningful examples. The manuals are looseleaf bound and fit into sturdy slip cases. One complaint is that the small type size and somewhat faded printing can cause eye strain.

The SCO support staff was courteous, helpful, and responsive. Its excellent reputation is deserved.

In nearly all respects XENIX feels like UNIX, as its heritage dictates it should. The enhancements to UNIX are welcome, especially file and record locking, which are critical in database applications, and interprocess communication and synchronization through semaphores. The **vi**, **more**, and **csh** programs are also helpful.

What XENIX lacks is speed. All UNIX implementations are hindered because the 8088 simply does not have enough horsepower to handle significant multitasking challenges. One background compile or **nroff** job puts the system into slow motion. Using lower priorities than the default of 20 for such jobs helps a little, but in multiuser situations, everyone is trying to get his or her work done, usually with little regard for other users.

All UNIX systems for the PC are hindered because the 8088 does not have enough power for significant multitasking challenges.

XENIX is ideal for single-user, multitasking operation. Given the rapid deterioration in performance experienced under multiuser conditions, particularly when text processing and compiling jobs are running, I cannot recommend its use in multiuser mode on the XT.

XENIX: $1,350; operating system alone: $595; development system: $595; text processing system: $395
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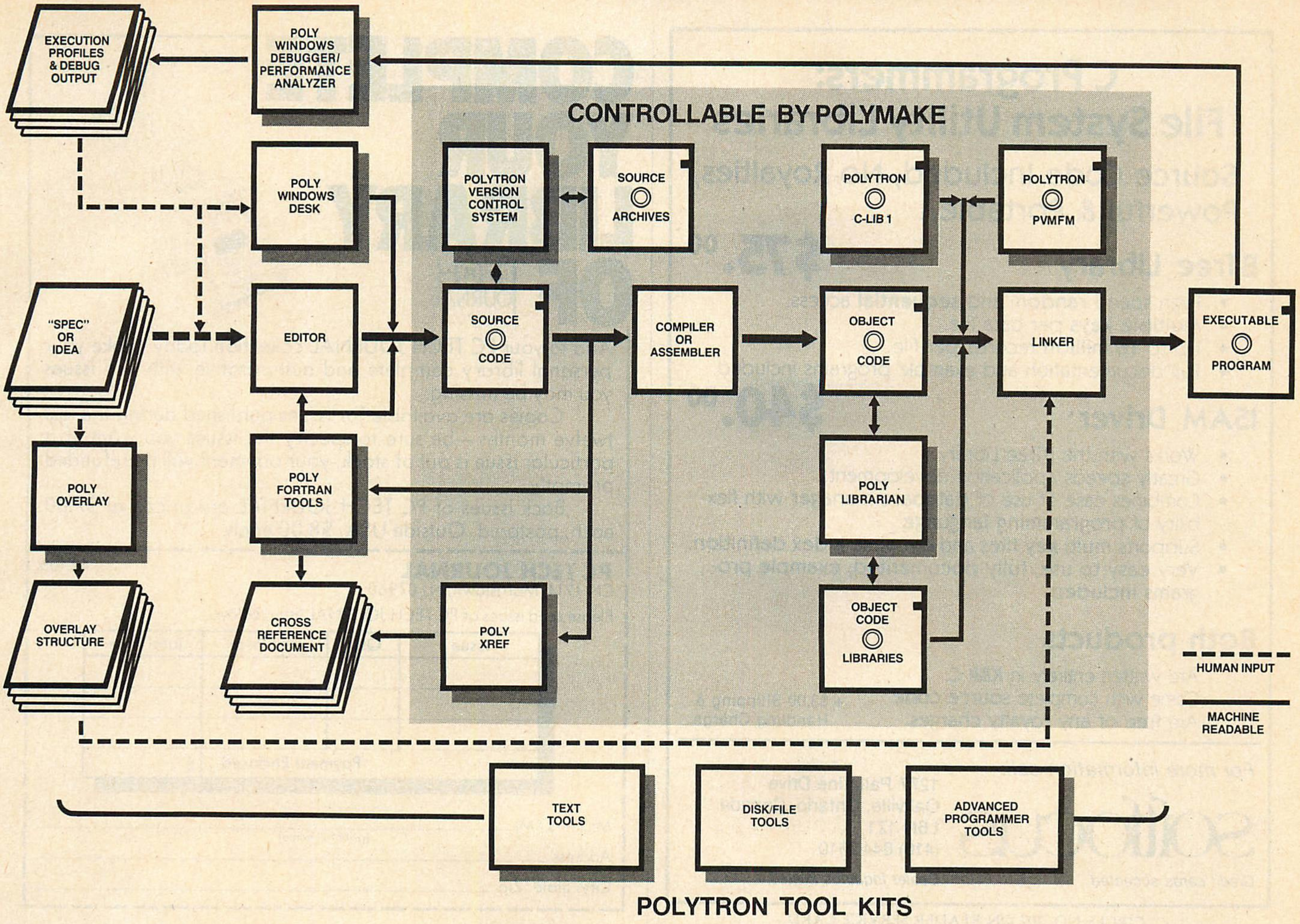

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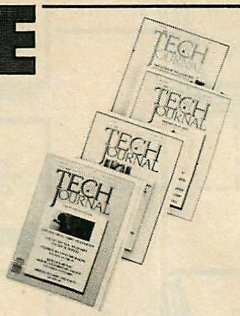

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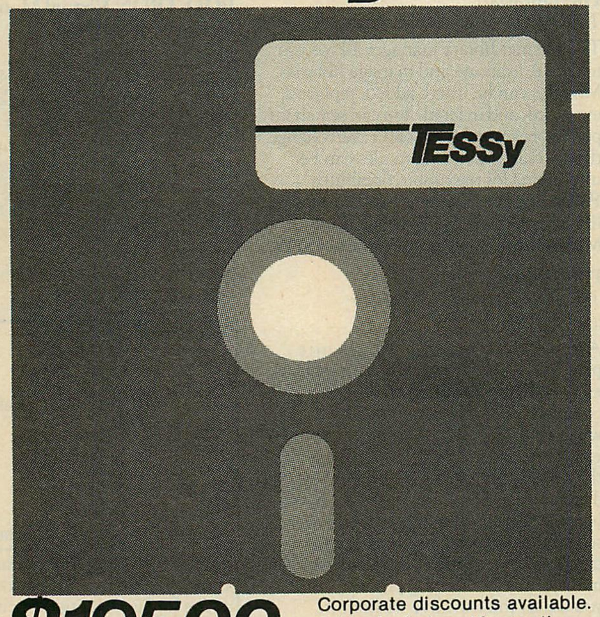

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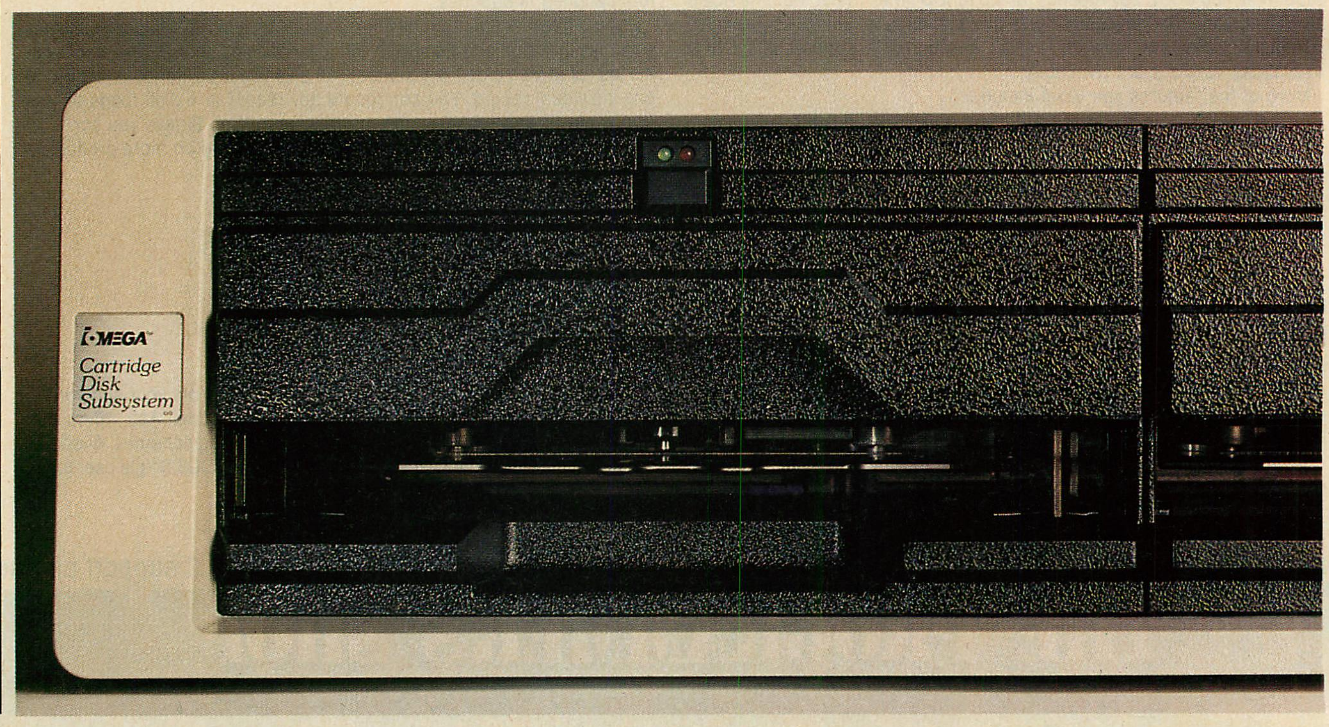

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number of strong points working in its favor. In addition to providing 20MB of on-line storage, it includes the capability to archive or back up a PC/XT or PC/AT hard disk or to back up one 10MB cartridge to another; it provides higher performance and reliability than the XT hard disk; and it allows virtually unlimited storage in 10MB segments.

The Bernoulli Plus host adapter card allows the user to boot his machine from a cartridge just as though the cartridge were an XT hard disk. A new release of the utility software (version 2.3) allows the original host adapter card to be used with the AT.

The eight-inch removable Bernoulli cartridges are unique; they each store 10MB of data, and they use flexible (floppy disk) media to achieve economical and highly reliable storage, unlike the rigid media that are used by removable Winchester, hard-disk cartridge drives. IOMEGA has effectively employed Bernoulli technology as a radically different approach to achieving flexible media stability and increased storage capacity in its cartridge drives.

The Bernoulli Box is named for Daniel Bernoulli, the Swiss mathematician who discovered the principle (now known as Bernoulli's Law) that the higher the speed of a flowing fluid (or gas), the lower the pressure. This law is commonly stated as follows: "Where the velocity of a fluid is high the pressure is low, and where the velocity of a fluid is low the pressure is high."

An example of the Bernoulli effect can be seen in nature. When a river is running through broad, open country, the water moves slowly, but when it comes to a narrow gorge its velocity increases dramatically. This principle, which can be used to explain why airplanes fly and baseballs curve, has been applied by IOMEGA to achieve flexible media stability in its cartridge drives.

Research to find ways to apply Bernoulli technology to mass-storage devices was begun in the early 1960s by the European electronics company, Phillips, with no significant practical results. In the early 1970s, IBM formed a team of researchers in Arizona and charged them with developing a practical application of Bernoulli's Law for mass-storage devices. IBM canceled the project, but in 1980 key members of the Arizona research team started their own company. In September 1982, that company, IOMEGA, became the first successfully to employ the Bernoulli principle in a marketable mass-storage device for microcomputers.

An explanation of IOMEGA's application of Bernoulli technology to the Alpha 10 Cartridge Drive Subsystem will help to point out many of the advantages of this unique mass-storage device. Normally, a floppy disk has a large amount of flutter and instability when it is spinning in an open space. As shown in the illustration below, the Bernoulli cartridge drive spins a floppy disk at 1,500 rpm, close to a stationary surface—the Bernoulli plate. According to Bernoulli's law, the combination of the spinning disk and the stationary surface generates a negative pressure between the disk and the plate; this results in a stabilizing effect.

This primary stabilizing effect "flies" the disk above the plate at a distance between four- and seven-thousandths of an inch and reduces flutter to less than one-thousandth of an inch. The pumping action that occurs when the disk spins over the Bernoulli plate causes air to be drawn between the surfaces and an opening on the plate.

A read/write head coupler, which is mounted on the plate and protrudes slightly above it, causes a secondary stabilizing effect by attracting the media over a small, localized region. The aerodynamically shaped coupler keeps flying height and flutter between 50 and 100 microinches. In addition, the aerodynamic contour of the head itself produces a tertiary stabilizing effect. Finally, a very stable "air-bearing" coupling to

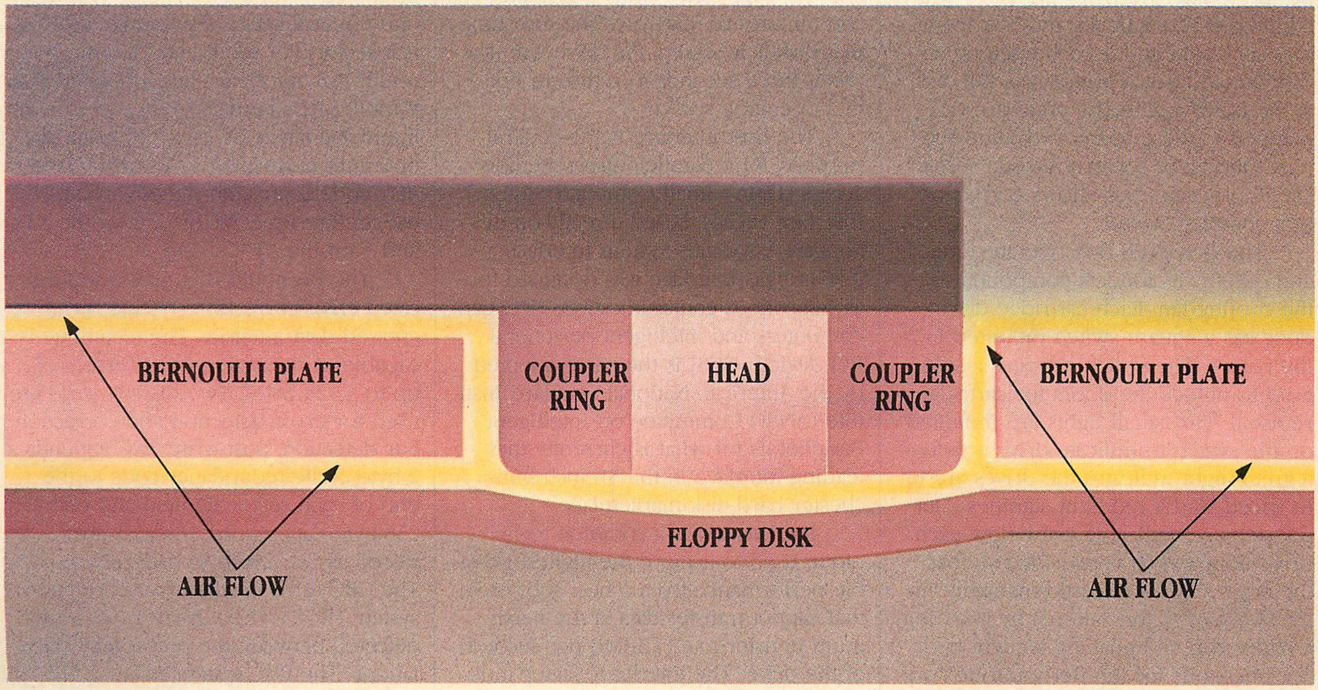


ILLUSTRATION • JOE SCROFANI

Spinning the disk above the Bernoulli plate reduces flutter, as does the head coupler attracting the media over a small area.

the disk media, created by the head, further reduces the disk flying height.

This three-level stabilization system results in an exceptionally stable head-to-disk flying height, which allows the extremely high recording density (between 10,000 and 20,000 flux changes per inch) that is necessary to record 10MB on eight-inch floppy-disk media.

The Bernoulli Box cartridge contains a single, flexible disk enclosed in a Lexan plastic housing that is 8¼ inches wide, 11 inches long, and about ¾ inches high. The cartridge provides a protected environment for the disk media. User contact with the disk is prevented by an internally latched cartridge door that opens when the cartridge is inserted into the drive. A mechanical switch on the front allows the user to write-protect the entire cartridge.

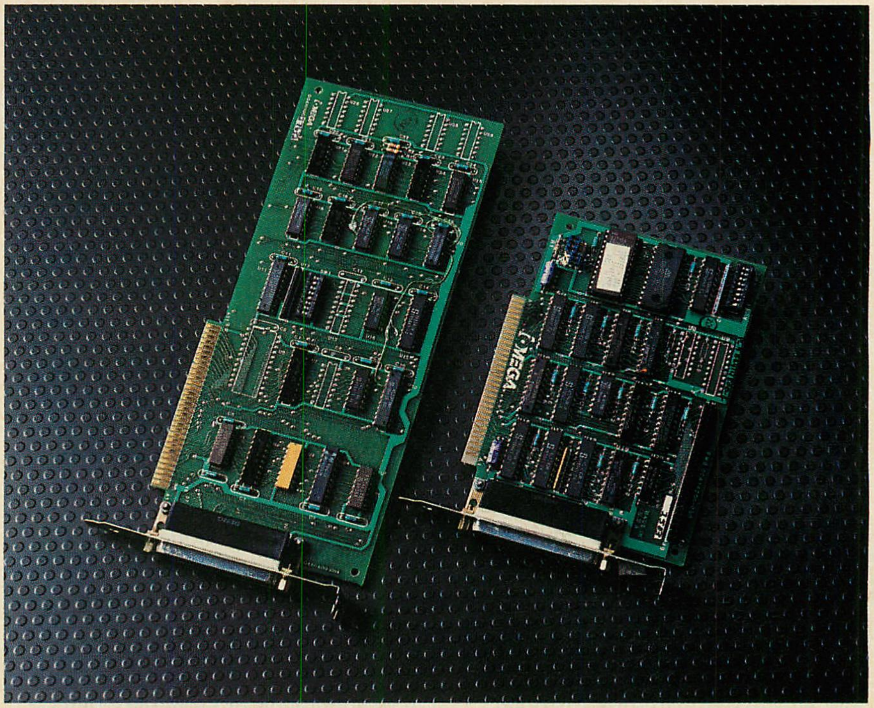
The disk itself is a 3-mil polyester-based substrate that is coated with a special high-energy oxide formulation to achieve reliable high-density recording—18,000 flux changes per inch (fcpi) and 300 tracks per inch (tpi).

A unique IOMEGA encoding method yields a linear density of 24,000 bits per inch. A proprietary run-length-limited (RLL) encoding scheme allows data to be packed tightly on the disk. RLL encoding translates the data bits entering the drive into a compact bit combination for actual writing on the disk, thereby squeezing more bits on the disk than the number of flux changes is normally able to record.

The disk surface is organized for effective use with 306 tracks, 64 sectors per track, and 512 bytes per sector. In addition, 4 spare tracks and 5 spare sectors are available for each track on a disk. When IOMEGA preformats the disk at the factory, defective areas are remapped to these spare tracks and sectors. One error-correction-code sector (ECC) on each track allows correction of a complete sector.

The Bernoulli Box operates quickly and quietly; its loudest component is the cooling fan. Each cartridge drive door has a square switch mounted in the center. The switch activates a solenoid to unlock the doors for cartridge removal. Two small lights are mounted on the switch to indicate drive activity—a green light indicates the drives are up to speed, and a red light signifies data transfers. A small hole just below each drive door switch is provided so that the door may be released manually (in the event of power failure) by inserting a paper clip and pushing straight back. Specifications for the Bernoulli Box are given in table 1.

PHOTO 1: *Adapter Cards*



With the Bernoulli Plus host adapter, right, the Bernoulli Box disks can be operated in either operating-system-controlled mode or add-on driver mode. Although it is not possible to boot from the Bernoulli Box disks with the Channel 3 DMA adapter, left, this adapter can be used in the PC/AT and most PC compatibles.

The idle drive shutdown feature (or automatic spindown) saves on disk wear and tear by stopping disk rotation if the drive has not been accessed for a certain period of time. In a two-drive system, the last drive that was accessed performs a continuous surface seek, and the other drive spins down after five minutes of inactivity. The next time that disk is accessed, the drive will take about three seconds to return to normal operating speed.

The host interface is the general-purpose, 8-bit parallel, direct memory access (DMA) Small Computer System Interface (SCSI), based directly on the Shugart Associates System Interface (SASI). This interface was designed for asynchronous communications between computers and intelligent peripheral I/O devices. SCSI is the name adopted by the American National Standard Institute (ANSI) Committee on Intelligent Peripherals for what is currently the leading interface in the 5¼-inch Winchester hard-disk marketplace.

Interleaving is a common technique used to achieve the highest possible performance from a host subsystem that cannot transfer data at the maximum transfer rate (1.13MB per second) of the drive. The interleave factor indicates the distance in physical disk sectors between logical data sectors. This allows additional time for the host computer to transfer data before the next sector arrives under the head.

An interleave factor of 1 (no interleaving) indicates that the logical data sectors are physically adjacent on the disk; a factor of 2 means that there is one physical sector separating each logical sector. For the PC and XT, the Bernoulli Box interleave factor is fixed at 4. With the AT's faster 80286 processor, an interleave factor of 2 may be used for optimum performance. The IBM fixed disk and adapter, on the other hand, use an interleave factor of 6 on the XT and 3 on the AT.

The Bernoulli Box uses a sophisticated error-correction scheme for increased data integrity. The technique is capable of correcting bursts errors of up to 5,123 bytes. Two distinct steps are used for error detection and correction. For detection, post-write CRC appends a 2-byte cyclic redundancy code to the end of each sector ID field and each 256-byte data record. (Sectors are stored as two 256-byte data records.) The CRC turns on the error-correction system (ECC) when discrepancies are detected between the polynomial calculations. The ECC system writes a 512-byte ECC sector at the end of each track

TABLE 1: *Bernoulli Box Specifications*

CAPACITY (bytes)	Cartridge	10,027,008
	Track	32,768
	Sector	512
	Record	256
PERFORMANCE	**DATA TRANSFER RATE**	
	Drive to controller	1.13MB/sec
	Controller to host	
	Single record burst (256 bytes)	1.13MB/sec
	Continuous records (same track)	896 KB/sec
	SEEK TIME (including settling time)	
	Minimum	10 ms
	Average	35 ms
	Maximum	75 ms
	Latency (average rotational delay)	20 ms
	Spindle speed	1500 RPM ±0.5%
	Track-to-track access time (for consecutive records over track boundary)	10.3 ms
	Start/stop time (average)	3-6 sec
RELIABILITY	**ERROR RATES**	
	Data	
	Recoverable	10^{10} bits
	Nonrecoverable (ECC at host interface)	10^{12} bits
	Seek	10^{6} seeks
	Mean time between failures (MTBF)	8,000 hours
	Mean time to repair (MTTR)	0.5 hours
	Service life	5 years
ENVIRONMENT (operating)	Temperature	10° to 46° C (50° to 115° F)
	Relative humidity	10 to 80%
POWER CONSUMPTION* (maximum continuous)	One drive and controller	55 watts
	Each additional drive	10 watts

**The Bernoulli Box contains its own power supply.*

The 35-ms access time of the Bernoulli Box, combined with a sophisticated error-correction and detection scheme, yields high performance and reliability.

that is generated by a sector parallel exclusive OR operation. Any sector on that track can be reconstructed when necessary by performing a parallel exclusive OR of all the other sectors on the track. The process is automatic and transparent to the host system.

OPERATIONAL ADVANTAGES

The Bernoulli Box provides several desirable advantages over conventional rigid-media technology. The highly compliant coupling between the disk and the media offers effective resistance to contamination and protection against hazards such as shock and vibration. Contamination in a hard-disk system often causes a collision between the head and a microscopic particle (dust or cigarette smoke, for example), which causes the head to rebound and crash into the disk surface. When this happens, both the head and the media surface are damaged, resulting in lost data and an expensive repair.

When an airborne particle enters the coupling area in the Bernoulli Box, an influx of air separates the media from the head temporarily and the particle is flushed around the head and out of the system. This purging action protects the head, the media, and the data.

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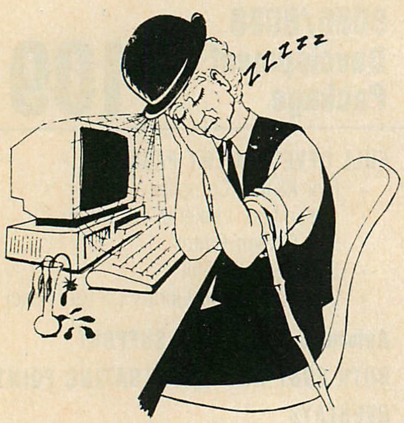

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PHOTO 2: *Bernoulli Cartridge*

The eight-inch flexible cartridge disk has a storage capacity of 10MB of data. Located in the upper right corner is a write-protect switch (shown in the inset).

Another common cause for head crash is the effect of shock and vibration. In a hard-disk system, the head-to-disk spacing is closely controlled by a precision gimbal system that attaches the head to the arm. The system is vulnerable to even moderate shock and vibration because of the close spacing of the head to the disk platter. Again, in the Bernoulli Box the compliant air coupling between the head and the media allows momentary uncoupling in response to shock or vibration.

Several different versions of the Bernoulli Box subsystem exist for the PC family. Two different host adapter cards and three utility software releases are available. The box itself, containing the Alpha 10 Cartridge Drive Subsystem, remains unchanged in all versions. The two different host adapter cards are the original DMA Channel 3 (model PCO) host adapter card and a newer Bernoulli Plus (Model PC1B) host adapter card. Both are shown in photo 1.

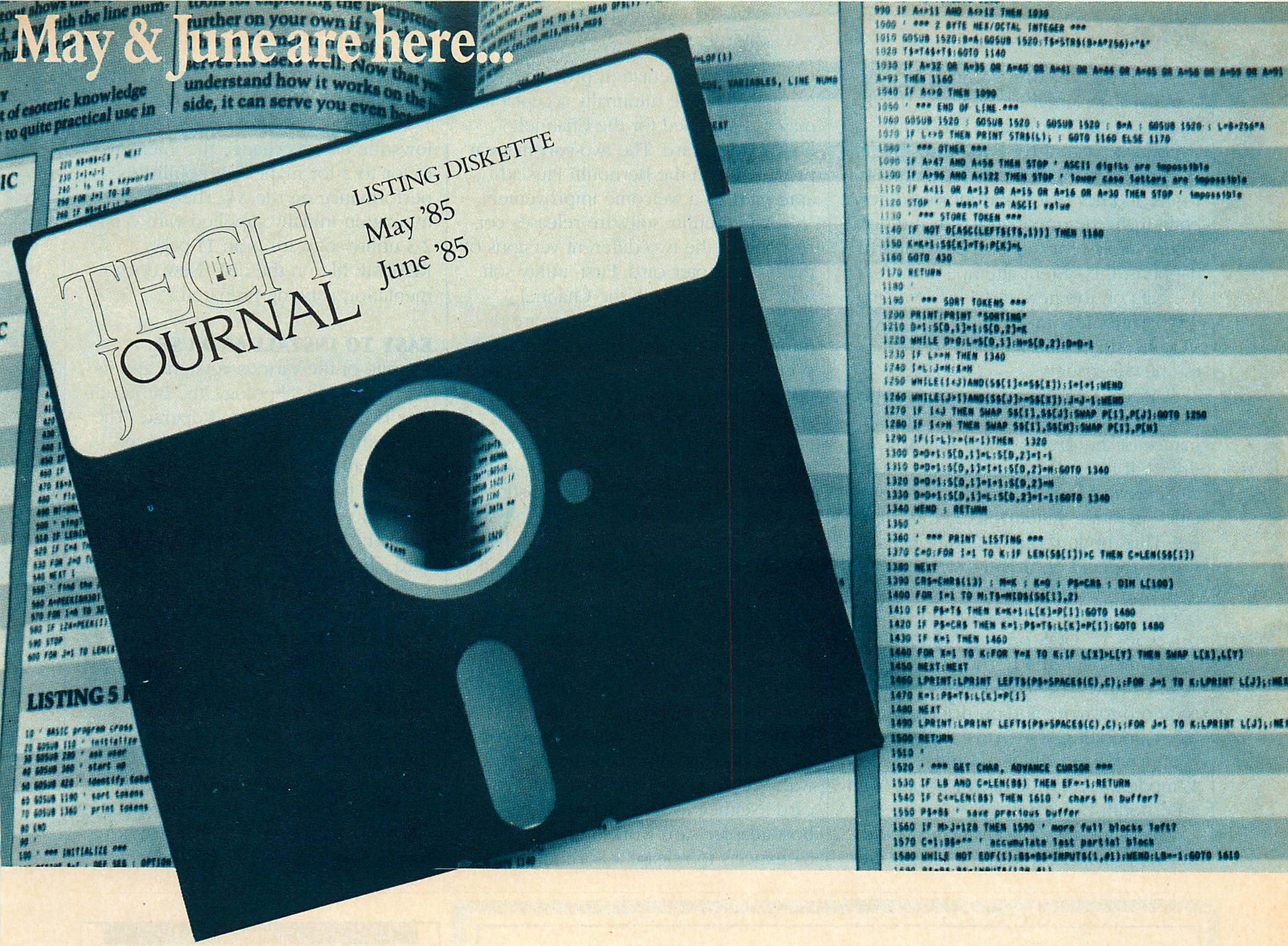
The primary difference between the two adapter cards is that the Bernoulli Plus card, released in November 1984, lets the Bernoulli Box operate as an XT hard disk on a floppy-disk-based PC or an XT. However, the Bernoulli Plus card will not work in PC compatibles. The Channel 3 card will work properly in most PC compatibles, but it does not support XT-like operation—that is, the system cannot be booted from the cartridge. Instead, the user must boot from the PC's floppy disk or the XT's hard disk and then switch to the desired Bernoulli Box drive. The Channel 3 adapter card does not support operating systems other than PC-DOS (or MS-DOS on PC clones).

The Bernoulli Plus adapter card enhances the performance of the Bernoulli Box on the PC by providing two modes of operation: mode 1, Operating System Controlled Mode; and mode 2, Add-On Driver Controlled Mode.

When mode 1 is in use, the IOMEGA 10MB cartridge drives in the Bernoulli Box are under operating-system control and respond just as a Winchester (hard) disk does. The system can be booted from a cartridge that contains PC-DOS. The normal fixed-disk commands for the specific operating system (PC-DOS/MS-DOS—FDISK; CP/M, CCP/M, or Concurrent PC-DOS—HDMAINT, and so on) will work with the Bernoulli Box cartridges as though those cartridges were a fixed disk.

The ability to use fixed-disk commands provides the user with the capability to store a complete and bootable operating system environment for the PC on a 10MB removable cartridge. The PC operating environment can be changed as easily as changing a single floppy disk.

Note that although partitioning of a cartridge disk is allowed, IOMEGA dis-



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courages the practice. Partitioning was originally designed for use with fixed-disk drives and can cause problems when used with a removable disk. It is possible to remove a cartridge disk and insert another that is partitioned differently from the one that was in the drive when the system was booted. When this happens, the system attempts to access the data on the new cartridge by using the partitioning information from the old one; this could result in lost data on the new cartridge.

Mode 2, Add-On Driver Controlled Mode, exists to optimize the performance of the IOMEGA Bernoulli Box drives. It frees the user from the inefficiencies and speed limitations of a specific operating system's fixed-disk drivers. This mode requires additional software—the add-on driver—which is loaded when the operating system is booted. IOMEGA supplies an add-on driver for PC-DOS on the utilities disk that comes with the Bernoulli Plus host adapter card. The technical information required to write add-on drivers for other operating systems is available from IOMEGA on request. Unlike mode 1, mode 2 cannot be used to boot from a Bernoulli Box cartridge.

Perhaps another advantage of the Bernoulli Plus host adapter card is the excellent documentation provided, compared to the minimally acceptable material supplied for the Channel 3 host adapter card. The two-part manual provided with the Bernoulli Plus adapter card is a welcome improvement.

Three utility software releases correspond to the two different versions of the host adapter card. First, utility software is shipped with the Channel 3 host adapter card; the versions are numbered up to 2.2. These utilities support PC-DOS versions 1.1 and 2.x, but not 3.0. This software will not work with the Bernoulli Plus card.

Second, the Bernoulli Plus host adapter card is also shipped with utility software. This software can be distinguished from that shipped with the Channel 3 adapter card because it has file names such as IFORMAT and ICOPY instead of the older file names, A10FMT20 and A10FDUP. This software will not work with the Channel 3 card.

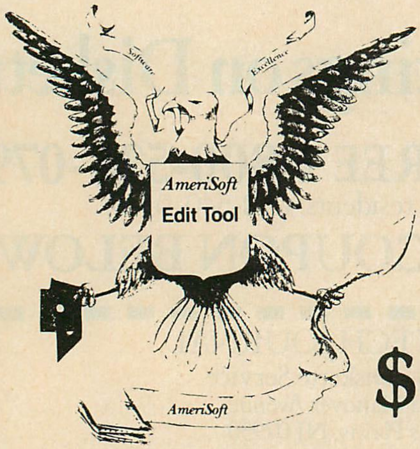
Finally, the newest release of the original utility software, version 2.3, allows the Channel 3 host adapter card to be used in the AT or with DOS 3.0 on a PC or XT. This software will not work with the Bernoulli Plus host adapter card. Neither will the Bernoulli Plus host adapter card work in the AT. IOMEGA expects to release a Bernoulli Plus-like host adapter card for the AT in the first half of 1985.

Version 2.3 software in the AT allows the user to change the interleave factor to 2 for higher Bernoulli Box performance on the AT. The only documentation initially supplied with version 2.3 utility software is an 11-page README file on the disk. New documentation is being prepared.

EASY TO INSTALL AND USE

In spite of the various versions and its sophisticated technology, the Bernoulli Box is easy to set up and operate. The user simply inserts the host adapter card in an expansion slot in the PC, plugs in the interface cable to the Bernoulli Box, then plugs in the power cables. The switches on the host adapter card are preset at the factory.

Switch-setting information to change the I/O port address or DMA channel is provided in sufficient detail to accommodate nonstandard installations or conflicts with other devices attached to the system. The Channel 3 host adapter card uses switches 2 through 5 on an eight-position DIP switch to control the I/O port address of the card. These switches are preset to 330H, but the selectable range is from 330H to 370H, in steps of eight.



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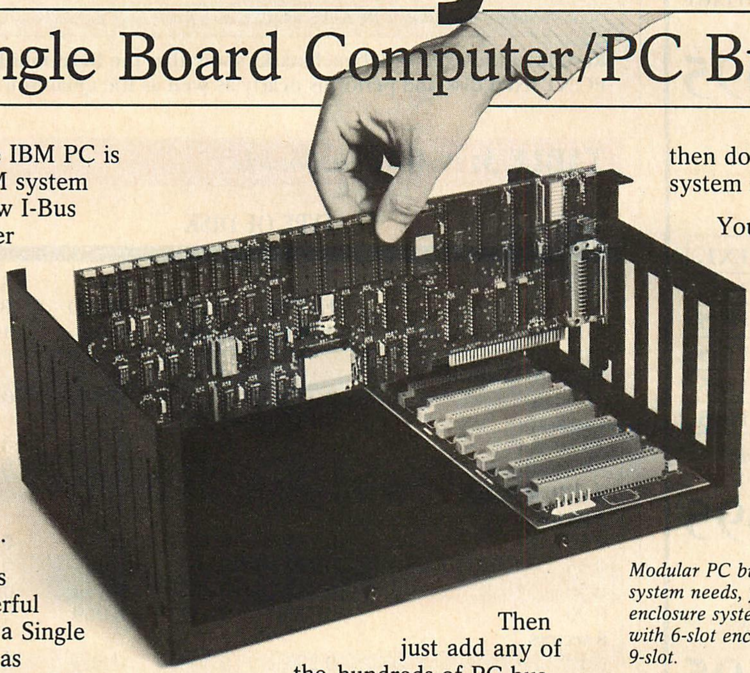

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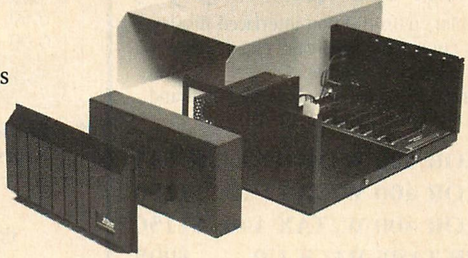

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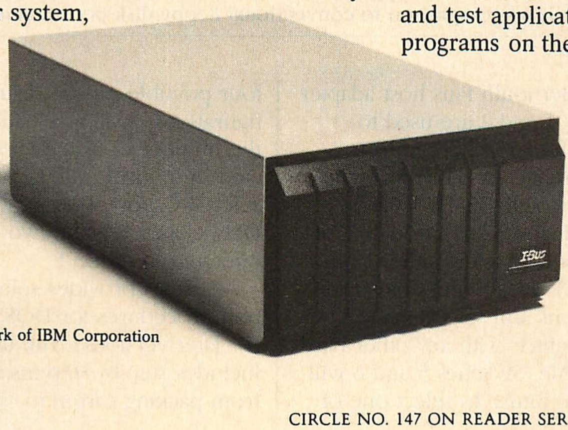

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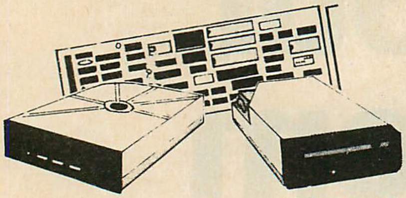

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TABLE 2: *PC and PC/XT Benchmarks*

TEST All times in seconds	TYPE OF DISK FLOPPY 360KB	PC/XT FIXED 10MB	PC QUANTUM 30MB	PC BERNOULLI 10MB	PC RAM DISK 360KB
SEQUENTIAL READ					
1 sector	0.212	0.022	0.022	0.041	0.003
8 sectors	0.437	0.071	0.041	0.060	0.016
16 sectors	0.706	0.126	0.066	0.082	0.033
24 sectors	0.934	0.187	0.091	0.103	0.049
RANDOM READ					
1 sector					
0.10*	0.111	0.070	0.034	0.061	0.004
0.33	0.210	0.120	0.052	0.062	0.003
0.50	0.236	0.160	0.054	0.062	0.004
0.90	0.310	0.240	0.069	0.081	0.004
8 sectors					
0.10*	0.360	0.120	0.052	0.070	0.019
0.33	0.473	0.160	0.071	0.075	0.016
0.50	0.481	0.210	0.071	0.088	0.016
0.90	0.563	0.300	0.093	0.110	0.019

Seek distance—the distance the heads traveled as a fraction of the width of the disk platter.

Results of the fixed-disk benchmarks show that the Bernoulli Box outperforms the PC/XT fixed disk and performs nearly as well as the Quantum 30MB disk.

TABLE 3: *PC/AT Benchmarks*

TEST All times in seconds	TYPE OF DISK FLOPPY 360KB	FLOPPY 1.2MB	AT FIXED 20MB	AT BERNOULLI 10MB	AT RAM DISK 1.4MB
SEQUENTIAL READ					
1 sector	0.030	0.033	0.003	0.041	0.000
8 sectors	0.187	0.225	0.027	0.044	0.005
16 sectors	0.365	0.451	0.052	0.044	0.005
24 sectors	0.544	0.676	0.077	0.066	0.008
RANDOM READ					
1 sector					
0.10*	0.111	0.161	0.044	0.062	0.001
0.33	0.212	0.262	0.044	0.041	0.001
0.50	0.232	0.287	0.054	0.060	0.003
0.90	0.312	0.431	0.069	0.081	0.001
8 sectors					
0.10*	0.291	0.365	0.063	0.055	0.003
0.33	0.390	0.396	0.071	0.066	0.003
0.50	0.412	0.473	0.074	0.077	0.003
0.90	0.489	0.643	0.091	0.099	0.005

Seek distance—the distance the heads traveled as a fraction of the width of the disk platter.

In the AT, the Bernoulli Box approximates the speed of the CMI 20MB disk. Of course, there is no comparison to conventional floppy disk performance.

For the Bernoulli Plus host adapter card, switches 1 and 2 are used to select one of four I/O port address groups, with ranges of 340H through 343H, 350H through 353H, 360H through 363H, and 370H through 373H. Switch 3 is used to select either DMA channel 1 or 3. Switch 4 disables DMA communications and selects ported I/O to prevent conflicts with any other hardware using DMA. Switches 5 and 6 will be used in the future to select one of four possible Alpha 10 subsystem configurations. Switches 7 and 8 indicate the number of disk drives to be operated in mode 1. The factory settings select I/O port address 370H to 373H, DMA channel 3, and two drives to be operated in mode 1.

IOMEGA provides software installation procedures for DOS 1.1 and 2.0 (or later versions). The user's manual includes step-by-step instructions, going from packing carton to operational sys-

tem in clear and concise stages. Each cartridge comes complete with handling instructions and labels. IOMEGA offers a *Technical Description Manual*, which is available upon request.

The software supplied by IOMEGA includes interface drivers for DOS 1.1 and 2.0 and utility programs to format and duplicate the disk cartridges. All disk-related commands of DOS are supported except DISKCOMP, DISKCOPY, and FORMAT. The utility software for version 2.3 also supports DOS 3.0. The IOMEGA formatting utility is used to format a cartridge; formatting time is less than two minutes. To back up or duplicate a cartridge, the IOMEGA duplication utility is used. Duplicating a cartridge takes less than four minutes.

DOS's installable device driver feature (for DOS 2.0 and later) is used to simplify software installation. The following commands are simply added to the CONFIG.SYS file:

For the Channel 3 host adapter:

DEVICE = A10 – 20.COM

For the Bernoulli Plus host adapter:

DEVICE = IDRIVE.SYS
BUFFERS = 4

The statement BUFFERS=4 increases the number of buffers that DOS uses (from the default of two for the PC and XT) for better performance.

In the PC used for this review, A: is a floppy drive, B: is vacant and used for a RAM disk, and C: is a 30MB Quantum hard disk. The hard-disk controller (Maynard WS-1) conflicts with the Bernoulli Box adapter on DMA channel 3, so the Bernoulli Box adapter DMA channel has to be reset. The Bernoulli Box drives are D: and E:.

In my AT, A: and B: are floppy drives, C: is the AT 20MB hard disk, and D: is a 1.4MB RAM disk (using DOS 3.0's VDISK and the extended memory address space); the Bernoulli Box cartridge drives are assigned to E: and F:. Incidentally, the Channel 3 host adapter card works fine in the extended (16-bit) slots on the AT.

In my Compaq I have two floppies (A: and B:) and I use C: and D: for RAM disks; the Bernoulli Box drives are E: and F:, using the Channel 3 adapter. This set-up works well for a Compaq that must do duty both on the road and in the office, because only the host adapter cable must be disconnected before the Compaq can be hauled away. Unfortunately, IOMEGA does not support the Bernoulli Plus host adapter card in the Compaq. Owners of other PC compatibles should check with IOMEGA to assure that the Bernoulli Box will work properly with their systems.

UNLIMITED APPLICATIONS

Once the user adjusts to the high speed and large increase in storage space the Bernoulli Box offers, its wide range of applications will become apparent. Initial uses may be loading programs and data on a cartridge, collectively updating from one cartridge to another, or from an XT hard disk to a cartridge.

Eventually, the user may get down to business and load a complete database on one cartridge, leaving the database management system on either the hard or floppy disk. This will provide not only a large amount of dedicated database storage and a rapid back-up capability but also the ultimate in security and privacy—the cartridge can simply be removed and locked up.

It is also possible to create a dedicated 10MB operating environment and file system for each user in a multiuser system. Copy-protected software will, of course, have to remain on the original diskettes for start-up.

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Epsilon reads and writes files 25% to 600% faster than competing editors. From its convenient keyboard macros to its facility that completes the names of commands, files and buffers, to its optimized incremental search, Epsilon has been designed for programming ease and speed. The number or the size of buffers you can have is unlimited and each buffer can hold a different file, or different versions of the same file. You can create as many windows as will fit on the screen, and display different buffers in each. Out of memory? Epsilon will automatically create and utilize a swap file.

Speed Comparison (In Seconds) with Other Editors

	Epsilon	Brief	Mince	Emacs
Start-up	**2.60**	4.11	1.43	24.93
Read 21K file	**1.06**	1.33	8.95	7.52
Write 21K file	**2.11**	14.30	6.05	7.95
Next Screen	**.19**	.24	1.33	1.80
String Search	**3.85**	7.04	4.49	8.41
I-Search	**3.85**	--	--	8.73
First Help	**8.30**	12.33	--	--
Other Helps	**.20**	11.64	--	--

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Integrated software packages are perhaps the most exciting possibility, especially those packages that reside on multiple floppy disks. Imagine being able to load all ten programs from a series of disks on the same removable cartridge, and still have plenty of room left over for data files.

An interesting variation to dedicated back-up (that is, one Bernoulli Box for each PC) is the shared back-up approach being used in multi-PC settings. Each machine is configured with a host adapter card, and the Bernoulli Box is rolled around from PC to PC and plugged in to accomplish periodic back-ups. The user can then secure his cartridge(s) to protect his files.

To measure the relative performance of the Bernoulli Box compared to other types of disk drives, the *PC Tech Journal* fixed-disk benchmark program was run (see "Fixed-disk Benchmarks," William Hunt, November 1984, p. 64). The results of the tests run on the IBM PC are given in table 2, and the results for the PC/AT are shown in table 3. The configurations of the systems are those described above.

The Bernoulli Box provides a level of performance that exceeds the XT hard disk (and many add-ons). The average time to find a given data segment on the XT is often twice that of the Bernoulli Box. Remember, the data-transfer rate for the Bernoulli Box is almost two times that for the XT. With an interleave factor of 4 on the PC, the Bernoulli Box benchmarks come close to the test times shown for the high-performance Quantum 30MB hard disk. Changing the interleave factor to 2 for the AT results in Bernoulli Box benchmark test times that are remarkably close to (and sometimes better than) those of the standard high-performance AT 20MB hard disk.

The suggested retail price for a dual-drive Bernoulli Box is $3,695; the single-drive version is $2,695. These prices includes one cartridge for the single-drive and two for the dual-drive unit. As a comparison, upgrading a floppy-disk-based PC with a 20MB hard disk, including supplemental power supply, typically costs about $2,600. A tape back-up system (that would equal the Bernoulli Box's inherent back-up capability) adds at least another $1,000; therefore, the prices for the two systems are in the same range.

If the PC expansion chassis with one 10MB hard disk (currently priced at $2,290) is used, as well as an extra 10MB hard disk (currently $1,395), the cost for 20MB adds up to $3,685. Adding another $1,000 for the tape back-up system results in a total cost of $4,675. The major benefit of the PC expansion chassis is its extra slots. The benefits of the Bernoulli Box are better performance and reliability, virtually unlimited storage capacity, and built-in, high-speed, back-up capability.

The built-in back-up capability also makes the Bernoulli Box worthy of serious consideration for XT upgrades. The PC expansion chassis with one 10MB hard disk will give the XT a total of 20MB for $2,290. When the tape back-up system is added to that, the price comes to $3,290.

A single-drive Bernoulli Box is also an attractive alternative to a tape back-up system for an XT owner. The entire 10MB hard disk can be backed up in less than four minutes—much faster than a tape system. In addition, the benchmark results in table 2 show that the Bernoulli Box clearly outperforms the hard disk in the XT (or in the expansion chassis); thus, it probably makes sense to use the Bernoulli Box for both applications and back-ups.

The utility software that comes with version 2.3 offers alternatives for the AT. Instead of buying the enhanced AT with its 20MB fixed disk for $5,795, purchasers can get the basic AT for $3,995

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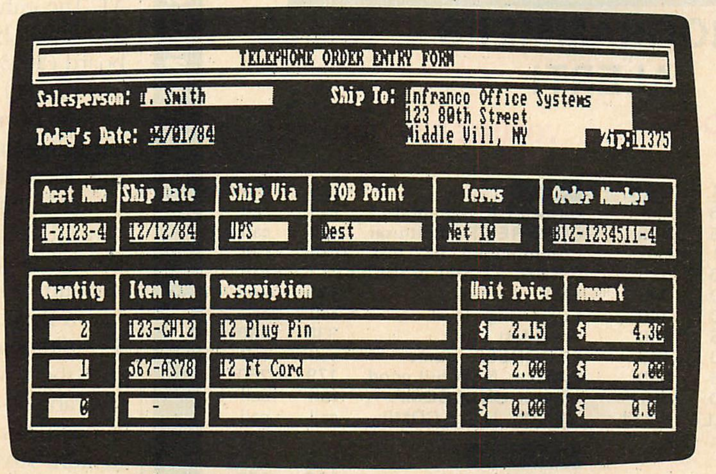

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(saving $1,800) and add the dual-drive Bernoulli Box for 20MB of removable cartridge storage. The excess outlay of $1,895 (at retail pricing) results in comparable performance, as table 3 indicates, and unlimited primary and back-up storage capacity.

Of course, the 20MB hard disk is not the only difference that exists between the enhanced AT and the basic AT. The enhanced model provides an additional 256KB of RAM on the system board ($495) and a combined serial and parallel I/O board ($150). This total of $645 brings the price of the 20MB AT hard disk to $1,155. This is a real bargain for a high-performance hard disk, which is difficult to pass up. With an enhanced AT, as with an XT, the Bernoulli Box becomes a good alternative to tape back-up.

A Bernoulli Box cartridge costs $79. Although this may sound expensive, the cost actually compares quite favorably to floppy disks—about 28 floppy disks of 360KB each are required to store 10MB of data.

Substantial discounts on the Bernoulli Box are available through some mail-order companies. IOMEGA does not directly support these mail-order discounters and indicates that some counterfeits are being sold.

IOMEGA has positioned the Bernoulli Box as a solid contender for PC high-speed, large-capacity storage upgrades. The outstanding performance and reliability, virtually unlimited storage capacity, and built-in, high-speed back-up capability make this product worthy of serious consideration. The Bernoulli Box operated flawlessly during my long evaluation period. In a year of extensive testing in three different PC environments and with countless software applications, not a single bit of data was lost. The performance, versatility, and reliability of IOMEGA's Bernoulli Box are quite impressive.

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Giovanni Perrone is a software engineering manager working for a major aerospace firm based in Boulder, Colorado. This article is an expanded and revised version of one written by Mr. Perrone that was first published in PC Week *on October 23, 1984.*

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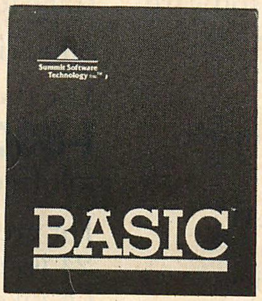

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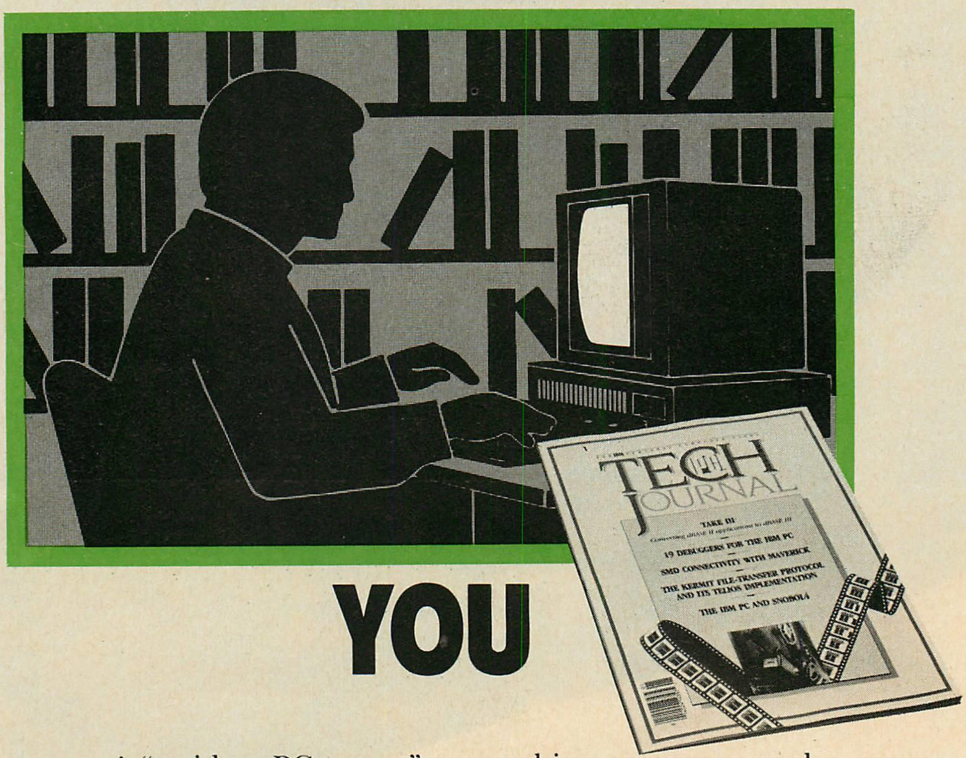

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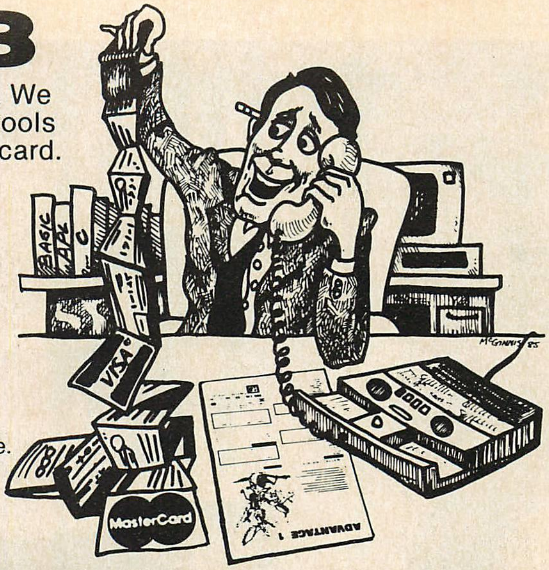

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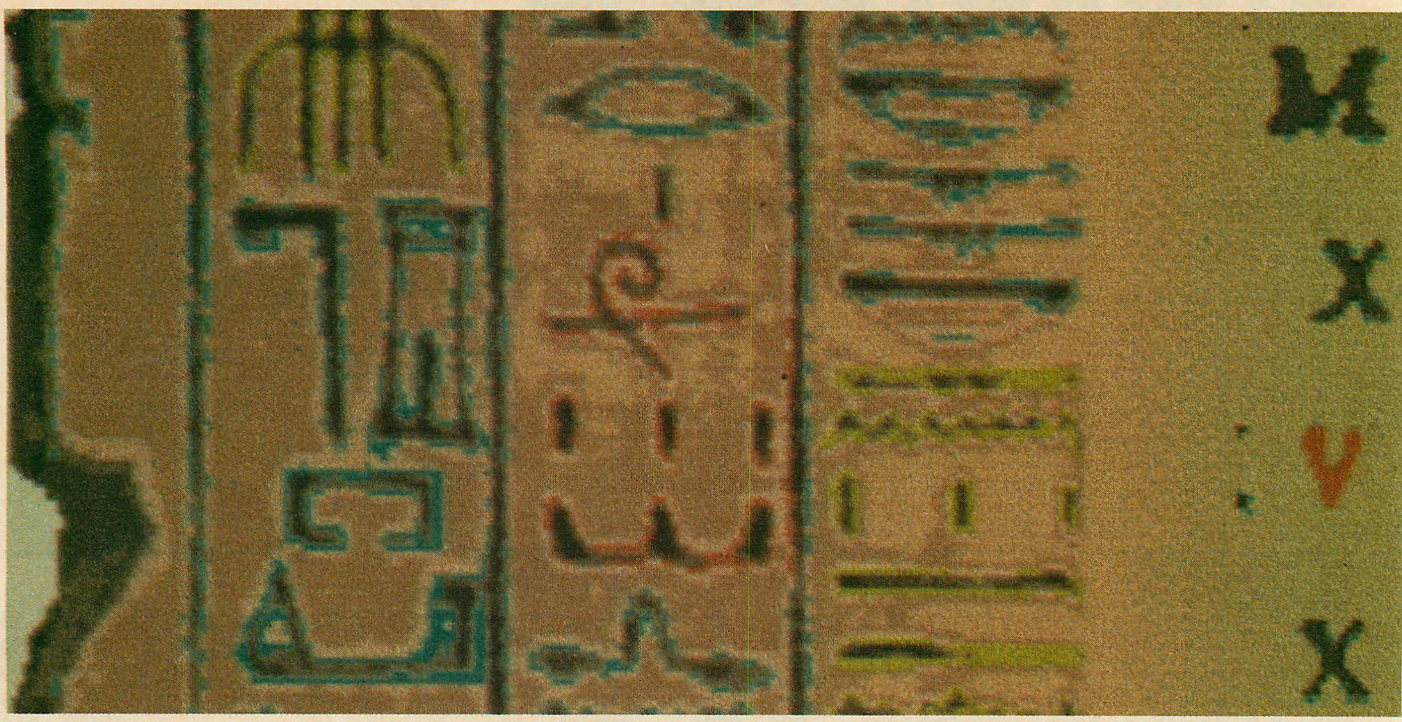


Encryption Software

Whether the use is shared hard disk or telecommunications, at least one of the seven encryption products reviewed here should meet most security needs.

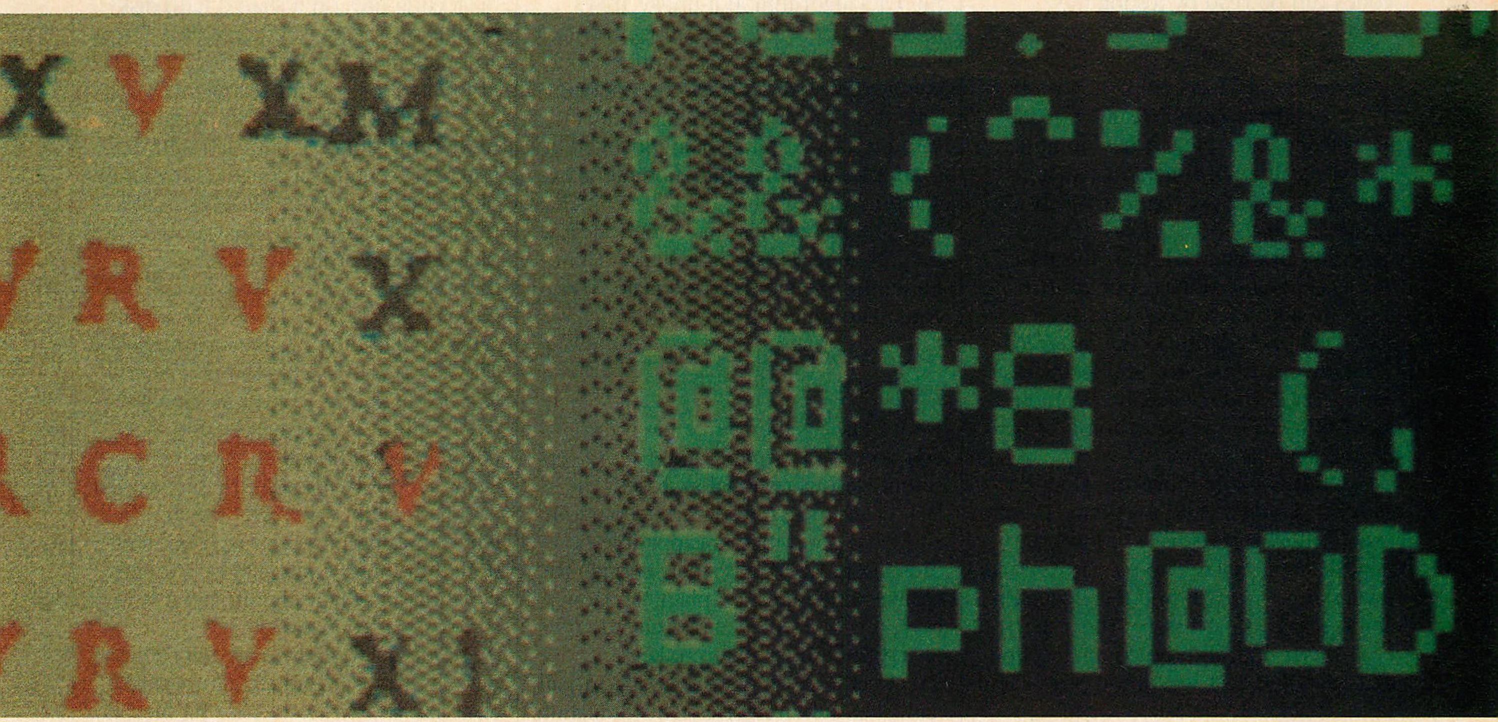
VICTOR MANSFIELD

The fundamentals of encryption and its role in microcomputer data security were discussed in "Encryption Methods" (Victor Mansfield, April 1985, p. 96). Part 2 of that article (May 1985, p. 157) examined the Data Encryption Standard (DES) and Public Key Cryptographic systems. This follow-up article reviews seven software encryption systems available for the IBM PC.

Encryption software can be divided into two groups: private key and public key systems. Of the seven products reviewed here, five are private key and two are public key systems. The security of private key systems relies on the secrecy of the key that specifies the character substitutions and transpositions that accomplish the encryption. Public key systems have two keys: a public key that anyone can look up in a directory and use to encrypt a message to the owner of the encryption key, and a private decryption key known only to its owner, which allows decryption of messages that have been encrypted with the public key.

The best known private key system is the Data Encryption Standard developed by IBM and approved in 1977 by the National Bureau of Standards and later by the American National Standards Institute (ANSI). Despite controversy about the cryptographic strength of the DES, it has become a popular standard for commercial applications and unclassified governmental data. Three of the packages reviewed, IBM's Data Encoder, Borland International's SuperKey, and Glenco Engineering's Data Padlock, are software implementations of the DES.

A more substantial programming effort must be made to implement a public key system. The great virtue of these systems is that they neatly solve



the difficult problem of securely distributing keys over an insecure network, and in some implementations they can also provide unforgeable digital signatures. The properties required for a simple public key system can be briefly stated by letting *P* represent plaintext or unencrypted data, *C* ciphertext or encrypted data, *E* key-dependent encryption, and *D* key-dependent decryption. Then it is required that:

- $C = E(P)$, meaning that ciphertext results from encrypting plaintext under the encryption key, *E*.
- $P = D(C) = D(E(P))$, or plaintext results from decryption under the decryption key, *D*.
- It is exceedingly difficult to find *D* from *E*.
- *E* cannot be broken by an attack in which an intruder chooses the data to be encrypted.

The last two properties allow *E* to be put in a public directory. All encryption and decryption keys are generated locally by individuals. *E* can be sent unencrypted to the directory, and *D* is kept secret by the individual user who generated it.

Rivest, Shamir, and Aldeman (RSA) developed an effective implementation of the public key system based upon some ideas from number theory. The security of their method rests upon the great computational difficulty of factoring very large numbers. In the RSA system the public encryption key consists of the pair of numbers (N, e) where *N* is a very large number (say $N >$ 1.0E200), which is the product of two large primes, and *e* is specially chosen for its unique properties. The secret key for decryption is (N, d) where *d* is also chosen for its useful properties. Encryption and decryption then consist of modular exponentiation with very large numbers, and therein lies the computationally intensive part of the algorithm.

PRIVATE KEY SYSTEMS

Data Encoder. IBM's non-copy-protected implementation of the DES encryption algorithm, is aggressively priced at $99.95. The documentation is done exceptionally well in IBM's usual style and layout. It leads a totally inexperienced user smoothly through all aspects of this powerful program, first defining such basic terms as *encryption* and *decryption,* then describing how to use the program's full-screen interface with its prompts, windows, highlighting, and optional color support.

A context-sensitive help system is always available. It is possible to return to previous entries, using the cursor arrows, and edit any of the input lines exactly as it is done in the IBM BASICA interpreter—a handy feature. A generalized file search, including hidden files, can be performed from within the program. In addition to being able to purge files, Data Encoder can write files with a hidden attribute for a little more security. The purge function is well integrated into the program: after an encryption, the user must answer a prompt about whether to keep the plaintext file or purge it. The program always warns if the name chosen for a file to be generated would cause an overwrite of an existing file.

An encryption key can be entered either as a standard ASCII string from 16 to 80 characters long, or as a hex equivalent. A string that is shorter than 16 characters provokes a warning that the key is not secure, but the user is able to proceed. An attempt to decrypt a is able to with the wrong key will elicit a message when the first block of data is decrypted. The program will continue, however, since this procedure may be used as a means of multiple encryption for additional security. Data Encoder fully supports paths, subdirectories, and wild card file specifications.

IBM also has available a version of Data Encoder, called the Quick Data Encoder (QDE), that is used only from the command line and requires 128KB memory rather than the 192KB for the full-screen interface version. QDE does not include the interactive features of the screen version, but it is useful in batch files in which it sets exit codes depending upon the outcomes of encryption/decryption operations. These

ILLUSTRATION • GARY ZAMCHICK / LEXICA

codes can be read by testing the ERRORLEVEL parameter. The error messages in both versions of the Data Encoder are clear and complete.

IBM's Data Encoder suffers from two deficiencies. First, it has no utility for converting unprintable characters into printable ASCII characters that can be transmitted over standard telecommunications systems. Unless the user has a communications program that implements a binary protocol such as XMODEM, he would need a program that converts binary to hexadecimal files. Data Encoder's second problem is its inability to suppress echoing of keys during keyboard entry.

On the whole, however, Data Encoder is a well-crafted program. The excellent menus, screens, windows, and help features make it so easy to use that even the novice will find the documentation nearly unnecessary. The experienced user will find the command line version, QDE, to have all the power and utility that could be asked for in a private key file encryption system. The encryption/decryption is lightning fast (see table 1). Data Encoder sets the price/performance standard for the private key systems reviewed here.

Data Padlock. Like Data Encoder, Data Padlock from Glenco Engineering uses the DES algorithm. But unlike IBM's product, Data Padlock is copy-protected and costs $50 more. Also, unlike other private key systems, it can be operated only from the command line. But since it requests a key after being invoked, it cannot be used in a fully noninteractive batch mode.

The program is not complicated, so the rather sparse documentation (nine unnumbered pages) is adequate. The command syntax is simply

```
A>DATALOCK <File1> [<File2>]
  [/S.../Q]
```

where File1 is the source file for encryption or decryption and /S.../Q represent various optional switches. The lack of distinction between decryption and encryption modes is possible because Data Padlock is smart enough to realize which files are plaintext. However, this convenience prevents double encryption under different keys.

Data Padlock does not support path names or subdirectories. This limitation, combined with the rigid copy-protection scheme, which requires the program to be operated only from the distribution master disk in a floppy-disk drive, makes the system generally awkward to use. This is especially painful, since one of its main applications is protecting files on a shared hard-disk system with many subdirectories. The arguments for copy protection do not justify this level of inconvenience.

Data Padlock has both purge and hidden file options, but each of these functions requires a separate invocation of the program. In order to encrypt a file, hide it, and purge the original plaintext, the program must be invoked three separate times. The keys can be either 8 ASCII or 16 hexadecimal characters, depending on the option chosen. The key is never echoed, but a switch can be set so that it must be typed twice until it is exactly repeated. According to the documentation, wildcards cannot be used in the file specification. Actually, wildcards may be used when purging files. Although not mentioned in the documentation, a syntax violation automatically displays a help screen—a nice feature.

One thoroughly unpleasant weakness is that Data Padlock allows unintentional overwrites of existing files. If only File1 is specified (omitting the optional name of the target file) and it is from a drive other than the default drive, the processed file will be written on the default drive under the name File1 without warning of any file that already exists under that name.

dBASE II VS.

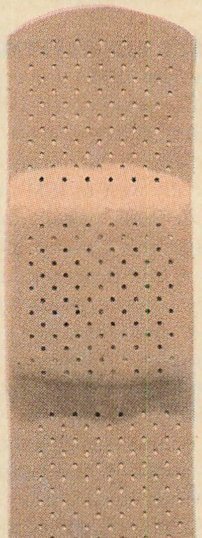


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TABLE 1: *Product Comparison*

SYSTEM	ALGORITHM	SUPPORT PATHS	COPY-PROTECTED	DOS FUNCTIONS	HEX CONVERTER	INTEGRATED PURGING	ENCRYPT TIME[1]	DECRYPT TIME[1]	PRICE
PRIVATE KEY									
Data Encoder	DES	Yes	No	Yes	No	Yes	15.1	15.1	$99.95
Data Padlock	DES	No	Fully	No	No	No	81.3	81.3	$150.00
P/C Privacy	Proprietary	Yes	No	No	Yes	No	26.0	31.0	$140.00
Super Encrypter II	XOR	Yes	Fully	No	No	Yes	31.8	31.8	$225.00
SuperKey	Proprietary	Yes	No	Yes	Yes	Yes	2.3	2.3	$69.95[2]
	DES	Yes	No	Yes	Yes	Yes	37.3	37.3	$69.95[2]
PUBLIC KEY									
Crypt Master	Hybrid	No	No	Yes	Yes	No	25.2	34.2	$245.00[3]
	RSA	No	No	Yes	Yes	No	614.0	4,000+	$245.00[3]
Phasor-Code 1000	Proprietary	Yes	Runtime	Yes	Yes	Yes	16.4	24.5	$595.00[4]

[1] *Encrypt/decrypt times are in seconds for 18KB files.*
[2] *Introductory offer.*
[3] *This price is for the 77-digit version. Crypt Master also is available in a 39-digit version for $95.00 and a 116-digit version for $395.00.*
[4] *Price includes communications support. Without it, the price is $495.00.*

As this comparison of the seven encryption software packages demonstrates, there is no clear relationship between the price of the product and its features or computational performance. Those with the highest prices are not necessarily the fastest.

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Record size	Unlimited	1024	4096
Multi key ISAM	Yes	Needs sorting	Needs sorting
LOCAL AREA NETWORKS			
File lock	Yes	No	No
Record lock	Yes	No	No
PORTABILITY			
8-bit → 16-bit	Yes	Yes	No
16-bit → 8-bit	Yes	Yes	No
MISCELLANEOUS			
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Report generator	Full	Limited	Limited
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Programmable function keys	21	0	0

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FIGURE 1: *Super Encrypter II Source File*

PLAINTEXT FILE CONTENTS:	THIS IS A SECRET MESSAGE.
Password 1 = pass1	pass1pass1pass1pass1pass1
Password 2 = key	keykeykeykeykeykeykeykeykey
CIPHERTEXT FILE CONTENTS:	Olckt'y6kzf) (d-o$g) 'zkgot

As shown in this example taken directly from the Super Encrypter II user's manual, the source file is XORed with passwords, one right after the other.

A peculiar and troublesome bug also exists in the purge function. When a file is about to be purged, the program first echoes its name, but only the first five letters of the file name and the three-letter extension. For example, if the user had three files, ORDER1.TXT, ORDER2.TXT, and ORDER3.TXT, and wanted to purge ORDER1.TXT, the program would display "Destroying ORDER.TXT–(y/n)." This could lead to confusion and disaster.

Although Data Padlock costs more than Data Encoder, it does less than half of what IBM's DES system does while taking more than five times as long. Further, Data Padlock is virtually useless with a hard disk.

P/C Privacy. P/C Privacy is a non-copy-protected implementation of a proprietary encryption algorithm by MCTel for $140. The program is so easy to use that the clearly written documentation is hardly necessary. The system includes three programs: ENCRYPT.COM, DECRYPT.COM, and PURGE.COM.

Entering *ENCRYPT* at the operating system prompt leads the user through a series of clear prompts asking for the name of the file to encrypt (source), the name for the encrypted file (target), and finally the encryption key. If the target file already exists, the program issues a warning and allows the user to abort. Encryption can be done directly from the command line by entering

```
A>ENCRYPT <sourcefile> <targetfile>
  KEY
```

For each file encrypted a checksum of the plaintext and the ciphertext is made and inserted into the encrypted file.

Earlier versions of P/C Privacy did not come with a program to purge the deleted file. (The term *purge* is defined as overwrite and then erase, not just erase.) The most recent version has such a program. Like its companion programs, PURGE can be run either from the command line or by going through the internal prompts.

DECRYPT is the mirror image of ENCRYPT except that the user must enter the key under which the original file was encrypted. The option is available to route the output to the screen or to a printer during decryption, in which case no plaintext file is generated.

If the decryption is correct, the checksums for the decrypted file will match those placed in the encrypted file; if the wrong decryption key is entered, the decrypted file will be unintelligible. Although both the original and the newly generated checksums appear on the screen just after decryption, the program provides no warning that the decryption was unsuccessful. This could be a problem for the user who must handle many files, each with a different key; by the time a mistake is discovered (perhaps the simplest typo) the user could have forgotten the correct key. MCTel could improve this program by making the checksums automatic and warning the user of any mistakes.

Since the P/C Privacy encryption process automatically converts any characters that lie outside the range of ASCII 33 through 126 (decimal) to multiple bytes lying within that range, all encrypted files are ready to be transmitted over standard telecommunications systems. Of course, this feature also makes the ciphertext files longer than the plaintext originals. Since the decryption program only works on data between two unique "stamps," encrypted text may be included inside of plaintext, and the entire file may be transmitted over standard telecommunications systems and decrypted without stripping the surrounding plaintext.

Another nice feature is that P/C Privacy is available on Apple/DOS and CP/M-80 so that files can be sent to those systems for decryption—providing that a secure distribution of keys is arranged. Even though the documentation says nothing about it, this program supports DOS 2.x path names.

Unfortunately, P/C Privacy includes no information about the nature of its encryption-decryption algorithm, and thus it is impossible to judge how secure the system is. Also, the purging function is not fully integrated into the program, so that as soon as an encryption is completed, the user is asked if he wants to purge the plaintext source

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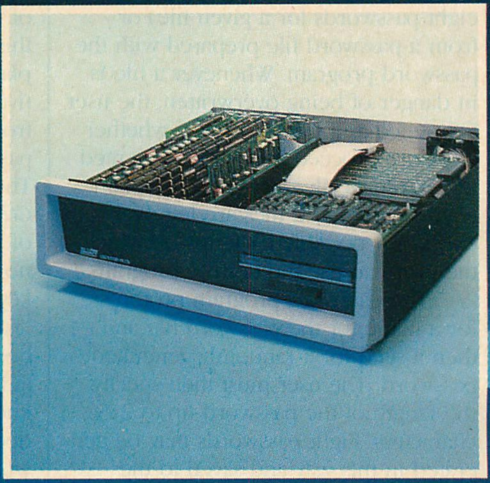

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file. It is too easy to leave old plaintext files around and thereby defeat the whole point of encryption. Another weakness is that when running P/C Privacy in the command line mode, the program does not warn the user about overwriting an existing file. Further, the program offers no method to suppress echoing of the encryption-decryption keys, so the potential exists for someone to peer over the user's shoulder and memorize the keys.

Super Encrypter II. Obsidian Computer Systems has entered the encryption software market with Super Encrypter II, a copy-protected program that sells for $225. The product is also being distributed by Wang Laboratories.

The system consists of four programs: ENCRYPT, DECRYPT, PASSWORD, and DESTROY (purge). Each has a clear set of prompts and is easy to use. Full support for path names and subdirectories is provided along with wildcard file specifications. Unfortunately, because of its rigid copy-protection scheme, Super Encrypter II cannot be stored and run from a hard disk.

The program encrypts using passwords supplied at the prompts (up to eight passwords for a given file) or from a password file prepared with the password program. Whenever a file is in danger of being overwritten, the user is notified and given a choice whether or not to proceed. Since the encrypted file automatically overwrites the plaintext, no unpurged files are left over except for possible back-ups on which the user can use the destroy program.

The password program prompts for a name for the password file and then a seed for a randomly generated password. The user must then specify the length of the password up to 255 characters. Eight passwords may be generated in this way and saved to the named password file, or a combination of randomly generated passwords and user choices may be entered. As the manual warns, passwords must be selected carefully, since some combinations, such as using two identical passwords, leaves the ciphertext file identical to the plaintext file.

One of the program switches is dangerous, as the manual stresses. The /s+ setting, the default for the program, means that if the user asks to encrypt *.txt, all the files in the current subdirectory and all those below it matching this specification are also encrypted. This means the user could start at the root directory of a hard disk and specify *.*, thinking that he is encrypting only the root directory, and end up encrypting the entire hard disk. If this questionable amount of power is to be given to the user, it should at the very least not involve the default value.

Another switch, /t+, used to send encrypted files over standard telecommunications systems, significantly weakens the encryption. With this switch on, the results of encryption are checked for unprintable ASCII characters; when they are found, the unprintable ASCII characters are replaced by their original plaintext characters. A much more cryptographically acceptable approach would have been to build a simple hex converter into the program.

The encryption algorithm for Super Encrypter II is a simple exclusive OR. The source file is XORed with passwords, one right after the other, as is shown in figure 1.

The first character of the plaintext, *T*, is XORed with the first character of the line below, *p*. The result is XORed with *k* to give *O*. The next character in the plaintext, *h*, is XORed with *a*, the result being XORed with *e* to give *l*, and so on. This can be done with as many as eight passwords. From the properties of XOR, it is easy to show that the effect of using *any number* of passwords like this is to take the *i*th character of the plaintext, *P(i)*, and XOR it with an effective key character, *K(i)*, which results from XORing the *i*th character of the password strings together in any order. Thus, the *i*th character of the ciphertext, *C(i) = P(i)* XOR *K(i)*. An even number of repetitions of the same password has no efffect since the resulting effective key is a bit string of zeroes.

A good encryption algorithm must be able to withstand several types of attacks. The exhaustive attack involves knowing the encryption algorithm and decrypting with every possible password until the plaintext is obtained. The DES, with its short key of eight characters, has been criticized for having too small a *key space*, the number of possible keys. In this respect Super Encrypter II is much better: the key space of its 255-character key is enormous, ruling out exhaustive attacks.

However, an algorithm must also be able to withstand analytic and statistical attacks. Consider, for example, the simple *known plaintext* attack, in which the plaintext and the corresponding ciphertext are known and the object is to find the encryption key.

The indexing feature of Super Encrypter II prevents the program from being totally vulnerable to such attacks. Using the present notation, the attacker knows *C(i)* and *P(i)* and seeks to find

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K(i). Finding all the keys is not necessary; finding the effective key is sufficient. To find *K(i)* start at the beginning of the ASCII character sequence and XOR each ASCII character with *C(i)* until *P(i)* is produced. The character that produces *P(i)* must be an element of the effective key, *K(i)*. If all of the *K(i)* is known, it is possible to decrypt any files that have been encrypted using the set of passwords that generated *K(i)*.

In practice, this merely means that a dummy file of any kind must be placed into the stream of files that are to be encrypted. It can even be put in a subdirectory below the one in which the encryption is to be done if the default switch /s+ is left on. In fact, a careless user may have already provided a dummy file by mistakenly encrypting a common file such as COMMAND.COM. Then the intruder can use the plaintext-ciphertext pair to find the effective key by the simple method just shown and go back and decrypt the rest of the files that were encrypted under that set of keys. This method requires that a dummy file equal to or greater than the repetition period of the effective key (only 15 in the example) be used; otherwise, the intruder is limited to decrypting files less than or equal to the length of the dummy file.

Super Encrypter II thwarts the above attack in two ways. First, its password program generates random passwords up to 255 characters long. The user is provided with a list of all of the prime integers up to 255 so that he can choose the longest ones and thereby give his effective key a repetition period much longer than any DOS file.

Second, an index is kept on the master disk so that, instead of always starting with *K(1)*, the program encrypts each file starting with *K(n)* where *n* is the sum of the lengths of the previous files encrypted with that set of passwords. When *n* becomes greater than the repetition period of the effective key, the starting index for the effective key is set to the last remainder. For example, assume the effective key repetition period is 450 and the first file is 1,000 characters long. Then the next file is XORed starting with character number 101 of the effective key. Without this indexing (missing in the earliest version) Super Encrypter II would be vulnerable to the simple plaintext attack. Unfortunately, the documentation does not make this clear, although Obsidian claims that an addendum will remedy this omission.

This indexing scheme is not effective for poor choices of passwords in which the repetition period of the effective key is less than the length of the dummy file. In this case, finding the effective key is always possible—it just may start somewhere in the middle of the encrypted dummy file. By modern standards of code breaking, the absence of either the dummy file or the target file is only a trivial complication for an attack to be XORed starting from the beginning of the effective key. The importance of long passwords is emphasized in Obsidian's documentation, but the full implications of the problem are not appreciated there.

If a user is scrupulous in picking appropriate passwords and uses the options switches properly, the program can serve him well—if he can live with an inconvenient copy protection scheme.

SuperKey. Borland International's SuperKey is a keyboard enhancer and set of utilities that include encryption using a proprietary algorithm. It is both an implementation of DES and non-copy-protected implementation for $69.95. The present review is restricted to the encryption utility; SuperKey in its entirety deserves a separate discussion. The copy reviewed was a beta test version that still had some loose ends in both the program and its documentation. For this reason my remarks will be largely restricted to design features.

Even in beta test form the documentation was complete and easy to follow. In addition, the encryption features were extremely easy to use because of some elegant incorporation of pull-down menus and clear prompts.

SuperKey is a RAM-resident program occupying about 50KB. Any file can be immediately encrypted by typing Alt/ to bring up the main menu and then *E* for the encryption utility. Within the encryption menu the program asks for the name of the file to encrypt; a password of up to 30 characters, which is not echoed and must be verified by typing again; and whether a printable ASCII text file is to be generated.

Answering *no* to the last question generates a file of eight-bit characters, while a *yes* generates a printable ASCII file that can be transmitted over standard telecommunications lines. An eight-bit encrypted file is immediately written over the original plaintext file. Purging is thus automatic. In the telecommunications case, the plaintext file is left intact, and a name must be supplied for the printable ASCII ciphertext file generated. This presumes that the need is for secure communications only, and that an encrypted version of the file is not generated for local secu-

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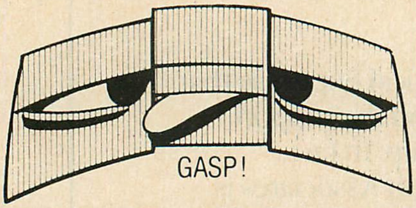

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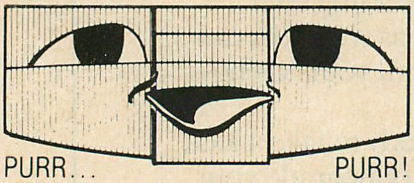

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rity. If local security is also required, the file must be encrypted again by a separate execution of the program. There is no separate purge function.

Encryption and decryption are invoked from the same command. The user does not need to specify which is being performed because decryption is the exact opposite of encryption. However, the user must specify whether a ciphertext file to be decrypted had been originally encrypted into binary or printable ASCII format.

SuperKey's encryption and decryption processes are very quick (see table 1). It has full support for path names and wildcard characters (both * and ?). One nice feature connected with the use of wildcards is that using them activates a prompt that asks for verification of each encryption/decryption just before it is performed. In this way, attempts to save time by using wildcard specifications will not accidentally encrypt or decrypt files.

The preparation for telecommunications of encrypted files is not a simple hex conversion, although (as with simple hex conversion) the file size is roughly doubled. Hex files, according to Borland, cause problems with some international facsimile machines that are unhappy with transmitting numbers. SuperKey was designed to avoid this problem by encoding all characters as letters. One deficiency of SuperKey is that a printable ASCII text file can overwrite any file that may exist with that name without first checking with the user.

SuperKey is not designed to allow for encryption or decryption from batch files. An encryption/decryption operation cannot be executed from the command line. Additionally, the algorithm is not sensitive to whether or not the key is in uppercase or lowercase. Intended as a convenience, this actually diminishes the key space significantly. These limitations must be put into the perspective that SuperKey is *not* primarily an encryption product but a keyboard enhancement utility that also does encryption and decryption.

As with other Borland programs, SuperKey is a large amount of functionality in a small amount of code at a low price. Because it is RAM-resident, it is always waiting for immediate use, and the pull-down menus and clear prompts simplify its use. The Borland algorithm is proprietary and very fast, but as with all proprietary algorithms, its cryptographic strength is uncertain. Its DES algorithm is quite fast for DES, and should be adequate for medium-security encryption.

PUBLIC KEY SYSTEMS

Crypt Master. Crypt Master is a non-copy-protected public key system by Digital Signatures. Its three different versions cost $95, $245, and $395, depending upon whether the prime number used in the RSA algorithm is 39, 77, or 116 decimal digits long, respectively. For all but the most exquisitely sensitive data, the 77-digit system is adequate. The system also includes an algorithm designed by Digital Signatures that is an RSA hybrid. Some of the algorithm is described in the manual, and the rest is available on request. The hybrid algorithm is necessary since the use of RSA with 77 digits (the version reviewed) makes it clear that 8088 machines do not have the computing power for use of the full RSA algorithm.

The Crypt Master documentation is excellent. It keeps the first-time user clearly in mind with its glossary of terms, good index, and sample use sessions. Technical information sections are included in the back of the user manual; these include a discussion of the RSA implementation that requires a firm grounding in college level mathematics. None of the technical detail is necessary for the operation of the program, however. The documentation is educational without being patronizing.

Because Crypt Master is a public key system, a pair of encryption and decryption keys, called *codes*, must be generated when using it. The user must first supply the name of the key pair or code. Next he must supply a secret pass phrase of up to 60 characters. Crypt Master offers the important option of switching on or off by function key the echoing of this secret pass phrase to the screen. The system checks to see that the same pass phrase has not been used elsewhere, since this would make the system more vulnerable to attack.

The user is then asked to enter 20 random characters that, in combination with the secret pass phrase, are seeds for the two large numbers that are the heart of the RSA algorithm. The random characters that are actually typed are inconsequential; only the time intervals between successive keystrokes is used. To avoid the fixed time interval of IBM's key inputs when the keys are held down, any key struck more than once in succession is ignored.

Next the system makes two successive prime number searches by using some standard techniques and a proprietary algorithm developed by Digital Signatures. The time that is required to generate the key pair varies depending upon the success of the prime number

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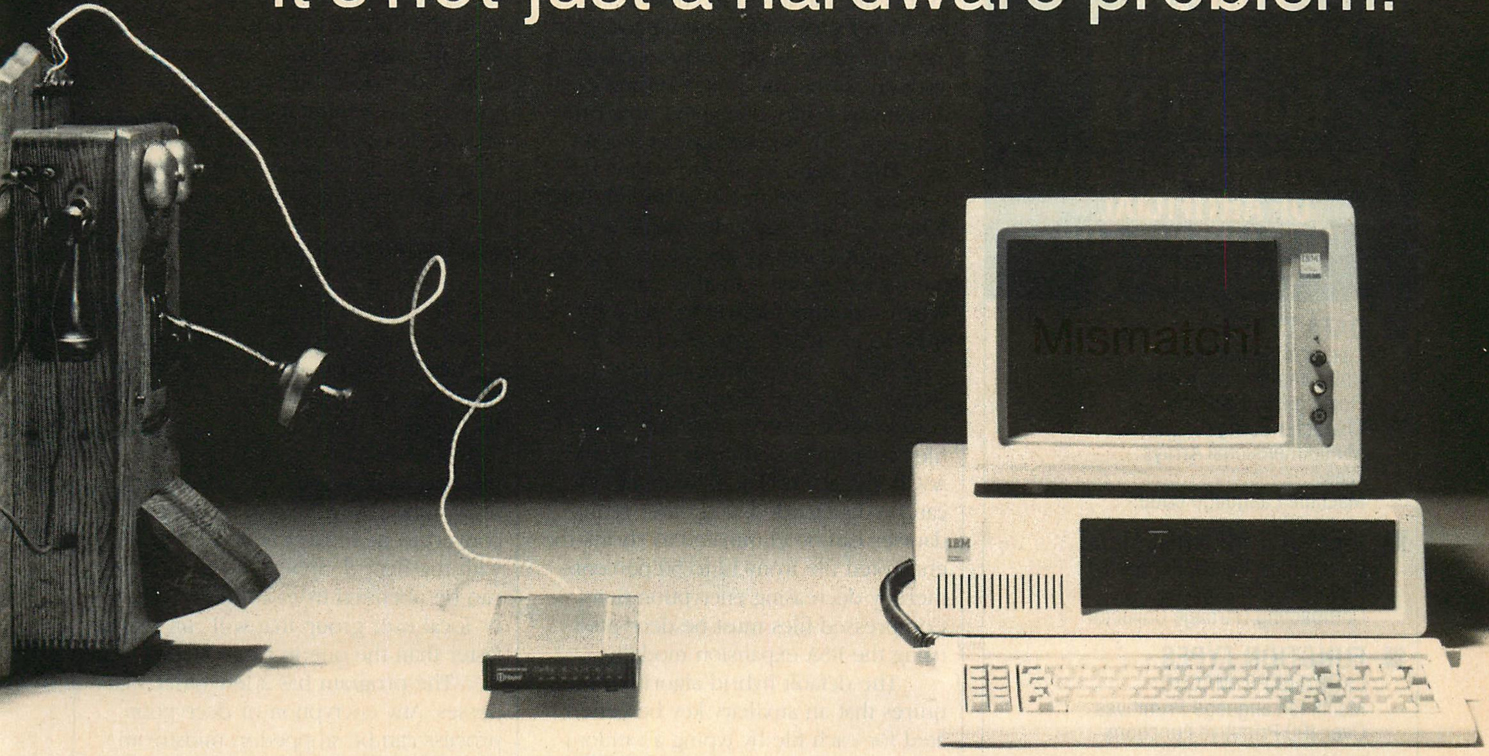

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searches, but it is generally less than three minutes. These codes or pairs of keys are kept in a file called PUBKEYS. Whenever a key is needed for encryption the user is shown the code names in this file and asked to choose one. A function for deleting existing codes is also provided. As the documentation strongly warns, this function can be dangerous if files encrypted under this key exist with no back-ups of the key.

The default algorithm for encryption and decryption is a hybrid cipher. Whenever an existing file name is chosen, Crypt Master issues a warning, and the user may enter another name. When inputting file names, the user may decide whether to use the RSA with file compression or the much slower, but more secure, pure RSA. File compression can be used only on text files containing nothing but printable ASCII characters. Then the eighth bit can be disregarded, and other redundancies can be eliminated to shrink the encrypted file from 12 to 50 percent, thereby decreasing encryption time. Compressed files must be decrypted using the RSA expansion mode.

The default hybrid algorithm requires that an auxiliary key be generated for each file by typing a random sequence of 48 different keys. The collection of time intervals between the 48 successive keystrokes is then encrypted using the RSA code previously specified and written out as the first record of the target file. The auxiliary key is used to encrypt the rest of the source file. This key is discarded immediately after its use. As soon as encryption begins, Crypt Master provides an estimate of the time needed to encrypt the file. The estimate is updated as the process begins. It is usually underestimated by as much as 50 percent.

When decryption begins, the user is shown the keys available in the PUBKEYS file and is asked to pick one and give the secret pass phrase associated with that key. A ciphertext source file and a plaintext target file are chosen. Again, the system gives an estimate of the time required for decryption and updates it during the process. When using the default hybrid decryption, the secret decryption key in the chosen RSA code decrypts the auxiliary key, which is the first record of the encrypted file. This auxiliary key decodes the rest of the ciphertext file.

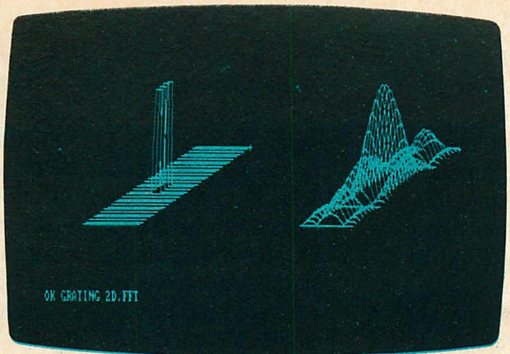
The secret decryption key of the pair is not encrypted by DES and placed in the key file. Instead, Crypt Master transforms the secret pass phrase into an integer, which is subtracted from the prime factor that constitutes the RSA secret key (called *d*). Only this *difference* is placed in the PUBKEYS file, and thus no information that would allow a reconstruction of the secret key, *d*, is contained in the file. PUBKEYS can be given to anyone to send messages securely. Alas, the hybrid cipher, despite all its elegance and speed, is not commutative, so only the RSA mode can be used for digital signatures. But this is hardly a big problem since critical information, such as digital signatures, secret keys, and short messages, could be handled with RSA, and the hybrid used for the rest.

To support a standard telecommunications system, Crypt Master contains a function that can convert encrypted files into printable ASCII characters and back to their original form. The transformation is a conversion into hexadecimal and back to eight-bit ASCII. Surprisingly, much more time is needed to convert to hex than to encrypt the file with the hybrid cipher. A hex converter can be obtained from a bulletin board or local user group that will run much faster than the one in Crypt Master.

The program has a few other weaknesses. Any encryption or decryption process can be stopped in midstream simply by hitting Esc; but if Ctrl-C is used out of force of habit, the system will lock up the next time Crypt Master is called from the DOS prompt. The screen can be thrown into disarray by typing Ctrl-L when asked for a file name. The program does not support subdirectories and path names. However, a listing of an alphabetically sorted directory is available from within Crypt Master. The system would benefit from integrating its purging function into the encryption process so the user does not have to switch to another part of the program to purge or possibly forget purging altogether.

Aside from these few lapses, the fine documentation, ease of use, fast performance, reasonable price, and general elegance of Crypt Master make it a good choice as a public key encryption system. In addition, it provides the high security and digital signature capability of genuine RSA. Created by two mathematicians formerly of the University of Chicago, the system is as clean and elegant as a mathematical proof.

PhasorCode 1000. PhasorCode 1000 by International Phasor Telecom Ltd. is a runtime, Prolok-protected public key system for $595, or $495 without communications support. This public key system is an implementation of a proprietary algorithm and not of RSA. This



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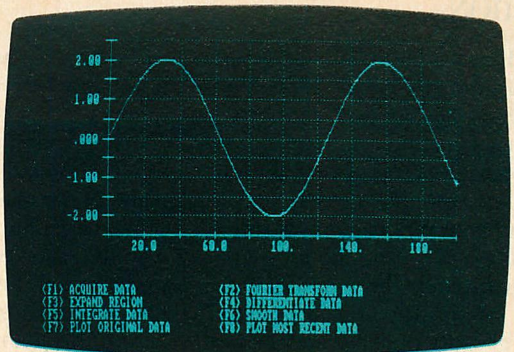

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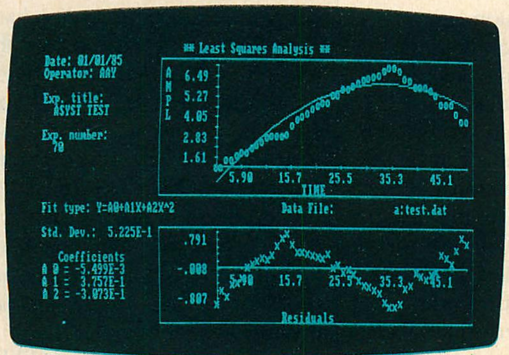

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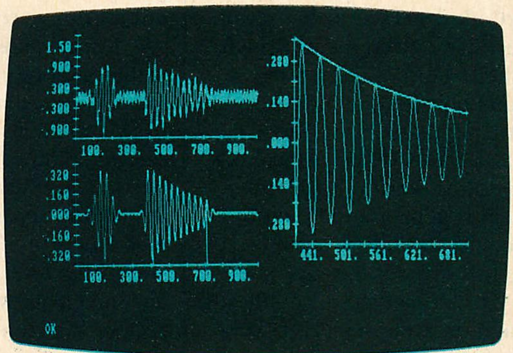

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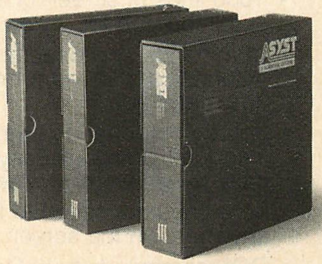

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explains why encryption and decryption are fairly fast on an 8088 machine, but it also prevents PhasorCode from providing digital signatures.

This big system, occupying almost all of a 360KB disk, offers much functionality and is well documented; special effort is taken to lead the inexperienced user carefully through the details of the system. The documentation includes a glossary of terms and a short history of encryption. International Phasor Telecom provides a toll-free 800 number for its customer support division in Vancouver, British Columbia.

PhasorCode 1000's available set of function keys for a given menu is highlighted at the bottom of the screen. A help key can be pressed at almost any time, but it is of limited value since it only repeats sections of the manual that must be traversed serially. A context-sensitive help system would be more useful. Since PhasorCode is a public key system, the first task for the user is to generate a pair of encryption (publically available) and decryption (secret) keys. This is done with the create command, which is invoked by a function key. At this point the user must enter a pass phrase (8 to 32 characters, such as "my dog's license # is 87654"), which encrypts the secret decryption key using the DES. The pass phrase must be typed a second time without echoing for verification. (Be careful to distinguish between the secret pass phrase and the secret decryption key.)

PhasorCode also has a utility that permits changing of the secret pass phrase at any time while the key pair remains the same. A name is given to the key pair file; when the program verifies that no other file uses this name, the user must enter a string of about 200 characters as a seed for the generation of the key pair. This typically requires less than two minutes.

Encryption is invoked from the top-level menu. The user supplies the name of the plaintext file and the name of the target file. If no other files exist with the name of the target file, the program asks for the name of the key file that contains the public encryption key. At this point the user must decide whether to purge the plaintext file. Decryption proceeds in the same way except that the user must give the correct pass phrase that will allow the DES to unlock the secret decryption key.

Key administration can be done within the program. A utility keeps three key files in a table that is displayed when an encryption key is to be selected. Entries in the table can be deleted or inserted. Any additional keys are kept in separate files on the disk. Full support for DOS 2.x subdirectories and path names is provided. At almost any time from within PhasorCode a directory search may be performed with the same power as the standard DOS Dir command. At the main menu a utility can also be accessed to use the DOS commands Dir, Erase, Rename, Type, and Copy, although it may be faster and easier to exit the program and issue the commands directly from DOS. In changing from one function to another (say from the electronic mail utility to encryption or from decryption to the DOS utility), PhasorCode is slow due to a great deal of disk access.

The communications option offers some extra functionality that takes encryted files and transforms their unprintable characters into printable ones so that they can be sent over standard telecommunications systems. This transformation increases the file size by about one-third. Before decrypting, such files must be put back into their original, encrypted form. If disk space is exhausted, all programs abort without a loss of data. A plaintext header can be placed on the encrypted files. Also included is a nice safety feature that will not allow a secret decryption key to be prepared for transmission without its first being encrypted.

The first version of PhasorCode tested, 1.2, had several bugs. The major bugs involved the inability to run anything but the simplest encryption and decryption functions from a hard disk. Transforming files to prepare them for telecommunications also caused problems. A new version cleared up the communications support, but would not load from the hard disk. Simplifying the environment by removing all attachments except the device driver for the hard disk and all operating system RAM-resident utilities did not help. The problem may involve the Prolock copy protection system.

The programs are big .EXE files run from within batch files rather than being memory-resident all of the time. Despite the repeated assertions in the manual that the system requires 256KB of memory to run, it will, in fact, run with 192KB, although slowly. Every time a major function is changed there is much disk grinding and waiting. The program is even slow when running from a hard disk, because every time encryption or decryption occurs, the Prolock protection scheme must first be read from the master floppy. The floppies also grind to replace parts of the operating system that have been overwritten and apparently need to be refreshed when moving among the vari-

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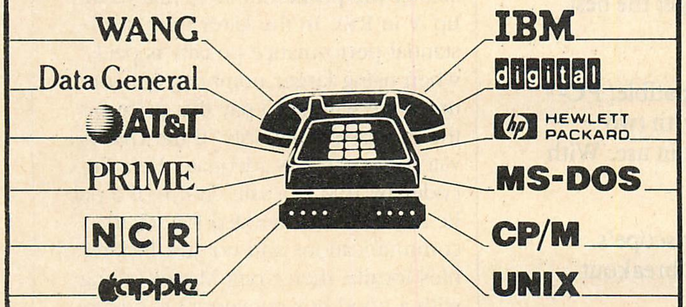

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ous utilities. All of this makes PhasorCode the slowest package reviewed.

The designers of PhasorCode allowed the DES to be used only for encrypting the decryption key. Adding a few lines of code would make the DES available for general use, thereby enhancing the overall versatility and power of the package. This option would be especially attractive in light of the proprietary nature of the encryption algorithm and the uncertainties inherent in such an approach.

CRYPTOGRAPHIC STRENGTH

Even with the programs that are considered easy to use, a nontrivial effort is required to encrypt files safely. Sloppy use of any of these programs can transform them into efficient file purge routines. The biggest problem lies in recalling which files are encrypted under which keys, without writing this information down where others can see it.

What level of security is achieved for this effort and expense? In the case of P/C Privacy, PhasorCode, and SuperKey, which employ proprietary encryption algorithms, it is impossible to know. The tradition in cryptography has been to make the algorithm widely available so that many disinterested and capable parties could examine it to determine its strength, as in the case of DES and RSA. Then, given these expert opinions, the burden on the user is just to keep his keys secret.

Both the DES and RSA are considered quite secure as measured by the number of CPU hours or years required to break these schemes. Both of them easily can be made more secure by multiple encryptions with different keys in the case of DES or by increasing the size of the prime numbers that make up N in RSA. In the latter case, a substantial performance penalty is paid when using larger numbers, but some users are willing to pay this price for the increase in security. If the DES private key system is adequate, Data Encoder by IBM is a safe choice. If a public key system is needed for secure communications and not just locking up files locally, then Crypt Master (along with a good hex converter) is recommended. Crypt Master also provides digital signatures. Since it also implements DES, SuperKey is good for medium-security encryption needs.

The user should keep in mind, however, that encrypting files, whether for a shared hard disk or for communications, is not the answer to all security problems. It is just as easy to purge encrypted files as it is to purge plaintext.

Access protection is another level of security that has to be considered. Even the best of tools in careless hands can be worthless, and when security is at stake a badly handled tool can be very damaging indeed.

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Victor Mansfield is chairman of the department of physics, associate professor of physics and astronomy, and adjunct professor of computer science at Colgate University. For the past few years he has worked as a consultant in computer security and formal verification of software correctness.

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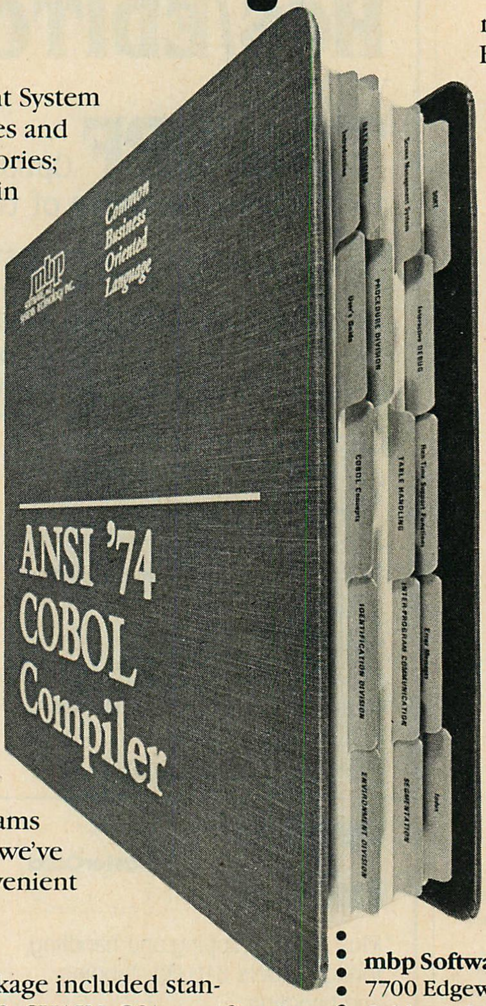

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Machine Specifics

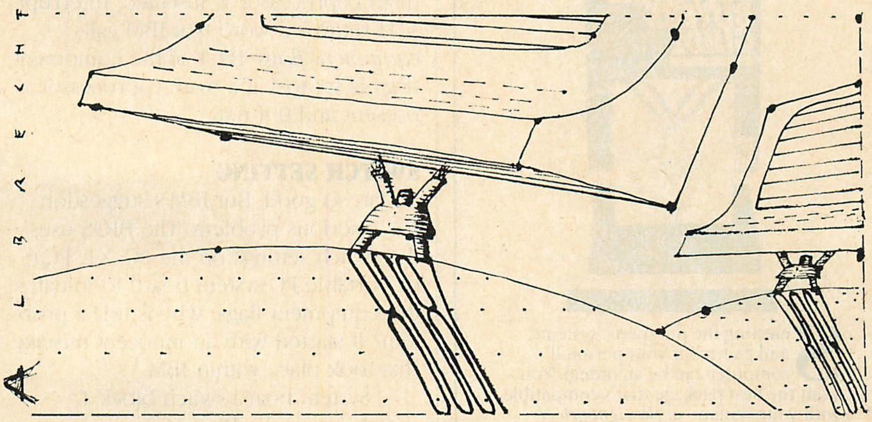
What kind of computer is this and does it have a math coprocessor installed?

Thou shalt write portable programs. Developers of personal computer software have this maxim deeply embossed on their foreheads. The brainwashing probably started in college when professors encouraged them to code class assignments in "standard" FORTRAN, "standard" COBOL, or "someday standard" C. Now, employers insist that their work be transportable to the whole IBM PC family, PC clones, future super-duper PCs that IBM hasn't even announced yet, and heaven help us, totally different computer architectures such as the Apple Macintosh.

Portability sometimes is more easily accomplished for computers from different manufacturers than for machines from the same manufacturer. For example, several popular applications programs for the PC have been ported to the Apple IIe with a minimum of effort, but the same applications do not yet run on the PC*jr* or the PC/AT.

These supposedly portable programs are often sensitive to the speed of disk drives, the speed of the microprocessor, differences in video I/O programming, or the absolute location of system variables in memory. Even though the computers that make up the IBM PC family are remarkably compatible, many subtle differences exist from model to model. For example, the PC*jr* has enhanced graphics capabilities and fancy sound generation while the AT has modes for memory protection and, aided by its 80286 CPU, causes programs to run much faster.

Another problem that plagues portability is optional equipment. Probably the most troublesome case in point is the high-performance math coprocessor. For a small investment, a user can add an 8087 to his PC, XT, or Portable PC. For a little more money, he can install an 80287 in his AT. Either of these coprocessors can significantly increase the speed of applications that do a great deal of number crunching, but neither of them comes as standard equipment. Programs have to decide on-the-fly if they are able to execute instructions on the math coprocessor.



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IDENTIFICATION CODES

A program must find out which computer it is running on so that it can take advantage of that computer's machine-specific standard features without sacrificing portability. The simplest way for a program to determine the type of computer it is running on is to test the machine identification byte located in ROM. Fortunately, IBM has supplied machine identification codes for each of the computers in the PC family. In all but one case, the members of the PC family have specific hardware differences. The only exception is the XT and Portable PC, which share the same machine ID because they have exactly the same system board.

The machine identification codes are 0FFH for the PC, 0FEH for the XT and Portable, 0FDH for the PC*jr*, and 0FCH for the AT. The machine ID byte containing the machine ID code is located in ROM at location F000:FFFE. The program shown in listing 2, MACHINE.ASM, gives the algorithm for checking the machine ID.

The batch file shown in listing 1, MAKECOM.BAT, has been provided to assemble, link, and convert from .EXE to .COM format all the programs described in this article. The user simply needs to execute the batch file with the name of the source file to be assembled after MAKECOM:

```
A>MAKECOM MACHINE
```

Notice the /r toggle at the end of the compiler invocation in MAKECOM.BAT. This instructs the macro assembler to accept mnemonics specific to the 8087 and 80287 coprocessor chips. Without the /r, the macro assembler will flag all coprocessor mnemonics as errors. The user should also keep in mind that release 1.0 of IBM's macro assembler did not support /r or anything connected with the 8087 coprocessor. Remember, in the beginning IBM did not acknowledge the existence of the 8087, much less support it through software. However, later releases of the company's macro assembler do support the numeric coprocessor.

If MACHINE is run on a PC-compatible computer, it returns a message reporting that the machine is not an IBM computer. When it is run on members of the PC family, MACHINE displays a message telling what the system is. The listing, MACHINE.ASM, can be modified by changing the code at the labels PC, XT, JR, and AT.

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To use the extra number-crunching horsepower of the 8087 or 80287, a program first must discover if a coprocessor is installed in the system. The math coprocessor is optional equipment; it cannot be blindly used if it is not there. Executing 8087 or 80287 instructions without an 8087 or 80287 installed can hang the system. There are two ways (one not so good and one excellent) to detect the presence or absence of an 8087 or 80287.

IBM recommends that programs use BIOS interrupt 11H to find out if a math coprocessor is installed. Interrupt 11H returns a word that IBM calls *equipment flags*. Bit 1 of the equipment flags is set to 1 if a math coprocessor is present and 0 if not.

SWITCH SETTING

So far, so good. But IBM's suggestion has a serious problem. The BIOS uses the switch settings on the PC, XT, PC*jr*, or Portable PC system board to initialize the equipment flags. Why is this a problem? It started with an innocent mistake that took place within IBM.

System board switch block 1, switch 2 tells the BIOS if the computer has a math coprocessor installed. If switch block 1, switch 2 is ON, then no coprocessor is installed. Conversely, if switch block 1, switch 2 is OFF, then a coprocessor is installed. The settings for this switch are counter-intuitive, ON means *no* and OFF means *yes*. That's where IBM's mistake comes in.

The *IBM Guide to Operations* states that the math coprocessor switch should be set more logically as ON for *yes* and OFF for *no*. Unfortunately, these incorrect switch setting instructions appeared in thousands of copies of the manual. The incorrect switch setting instructions have been followed by so many dealers and PC owners that the equipment flags are no longer a valid way to find out if a math coprocessor is present, even if IBM says so.

Those users who trust the switches to be accurate, however, can use the program in listing 3, MATHSWIT.ASM, to read the BIOS equipment flags. The program prints out a message to let the user know if the BIOS thinks the machine has an 8087 or 80287 installed. Like MACHINE.ASM, MATHSWIT.ASM can be assembled and converted to a .COM file by using MAKECOM.BAT.

If the BIOS interrupt 11H cannot always be trusted, how can the user reliably find out whether or not a math coprocessor is present? The only sure way is to query the chip itself. This is not as easy as it sounds because there are two different math coprocessors: the 8087 for the members of the PC family that use the 8088 microprocessor, and the 80287 for the AT.

No one knows the problems associated with math coprocessor detection better than Microsoft, the creators of DOS and a host of software development tools for the PC. When the AT was first introduced, Microsoft got caught in an embarrassing situation. It was smart enough not to trust the BIOS's assessment of whether a math coprocessor was present; but it used an algorithm to query the 8087 that did not work properly with the AT's 80287. The result was that several of Microsoft's products, including the MS-Pascal and MS-FORTRAN compilers, falsely thought that an 80287 was present on an AT even when it was not. This resulted in the compilers generating code that routinely gave false results for math operations when an 80287 was not present. (See "Pascal Bugs," Ted Forgeron, *PC Tech Journal*, May 1985, p. 199.)

MATHCHIP.ASM, the program in listing 4, uses a math-coprocessor-detection algorithm that works just as well with the 80287 as it does with the 8087. The technique used in the algorithm came from the microprocessor components group at Intel: the fninit instruction goes out and attempts to initialize the coprocessor. No harm is done if a coprocessor is not installed. Then, the coprocessor is queried for its control word. If an 8087 or 80287 is present and operative on the bus, it will return 03H in register AH. If no coprocessor is installed, since AH was originally cleared, lack of a coprocessor will leave the 0 value in AH.

One side benefit is that the core of the algorithm used in MATHCHIP.ASM does not depend on a specific brand of computer, BIOS, or DOS. It can be run on any computer that has a member of the iAPX 86 or iAPX 286 processor family as its microprocessor.

If MATHCHIP and MATHSWIT give conflicting answers, the computer they were run on is a victim to the *IBM Guide to Operations* error. The problem will be corrected by changing the switch settings as described above. Having total trust in switch settings can prove to be hazardous—it is necessary to look at the hardware itself to be absolutely sure.

Ted Forgeron is vice-president of systems software engineering at Multisoft Corporation located in Beaverton, Oregon.

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LISTING 1: MAKECOM.BAT

```
masm %1; /r
link %1;
exe2bin %1
del %1.com
ren %1.bin %1.com
del %1.exe
```

LISTING 2: MACHINE.ASM

```
;
; Machine Identification
;

id_base equ     0f000h                    ;segment for machine id
id_off  equ     0fffeh                    ;offset for machine id
pc_id   equ     0ffh                      ;id for IBM PC
xt_id   equ     0feh                      ;id for XT and Portable
jr_id   equ     0fdh                      ;id for PCjr
at_id   equ     0fch                      ;id for PC AT

code    segment public

assume cs:code,ds:code

        org     100h                      ;set up as a COM file
start:  jmp     begin

pc_msg  db      'System is an IBM PC','$'
xt_msg  db      'System is an IBM PC XT or Portable PC','$'
jr_msg  db      'System is an IBM PCjr','$'
at_msg  db      'System is an IBM PC AT','$'
no_msg  db      'System is not an IBM computer','$'

;
; Check machine identification at location F000:FFFE
;

begin:  mov     ax,cs                     ;set up ds
        mov     ds,ax                     ; to same segment as cs
        mov     dx,id_base                ;move base of machine id
        mov     es,dx                     ; into es
        mov     al,es:id_off              ;get machine id
        cmp     al,pc_id                  ;is it an IBM PC?
        je      pc                        ; yes
        cmp     al,xt_id                  ;is it an XT / Portable?
        je      xt                        ; yes
        cmp     al,jr_id                  ;is it a PCjr?
        je      jr                        ; yes
        cmp     al,at_id                  ;is it an AT?
        je      at                        ; yes
        mov     dx,offset no_msg          ;print not an IBM msg
        jmp     print                     ;
pc:     mov     dx,offset pc_msg          ;print IBM PC msg
        jmp     print                     ;
xt:     mov     dx,offset xt_msg          ;print XT / Portable msg
        jmp     print                     ;
jr:     mov     dx,offset jr_msg          ;print PCjr msg
        jmp     print                     ;
at:     mov     dx,offset at_msg          ;print AT msg
print:  mov     ah,09h                    ;dos 9: print string
        int     21h                       ;call dos function
        mov     ah,4ch                    ;dos terminate program
        int     21h                       ;call dos function
code    ends                              ;
        end     start                     ;start is entry point
```


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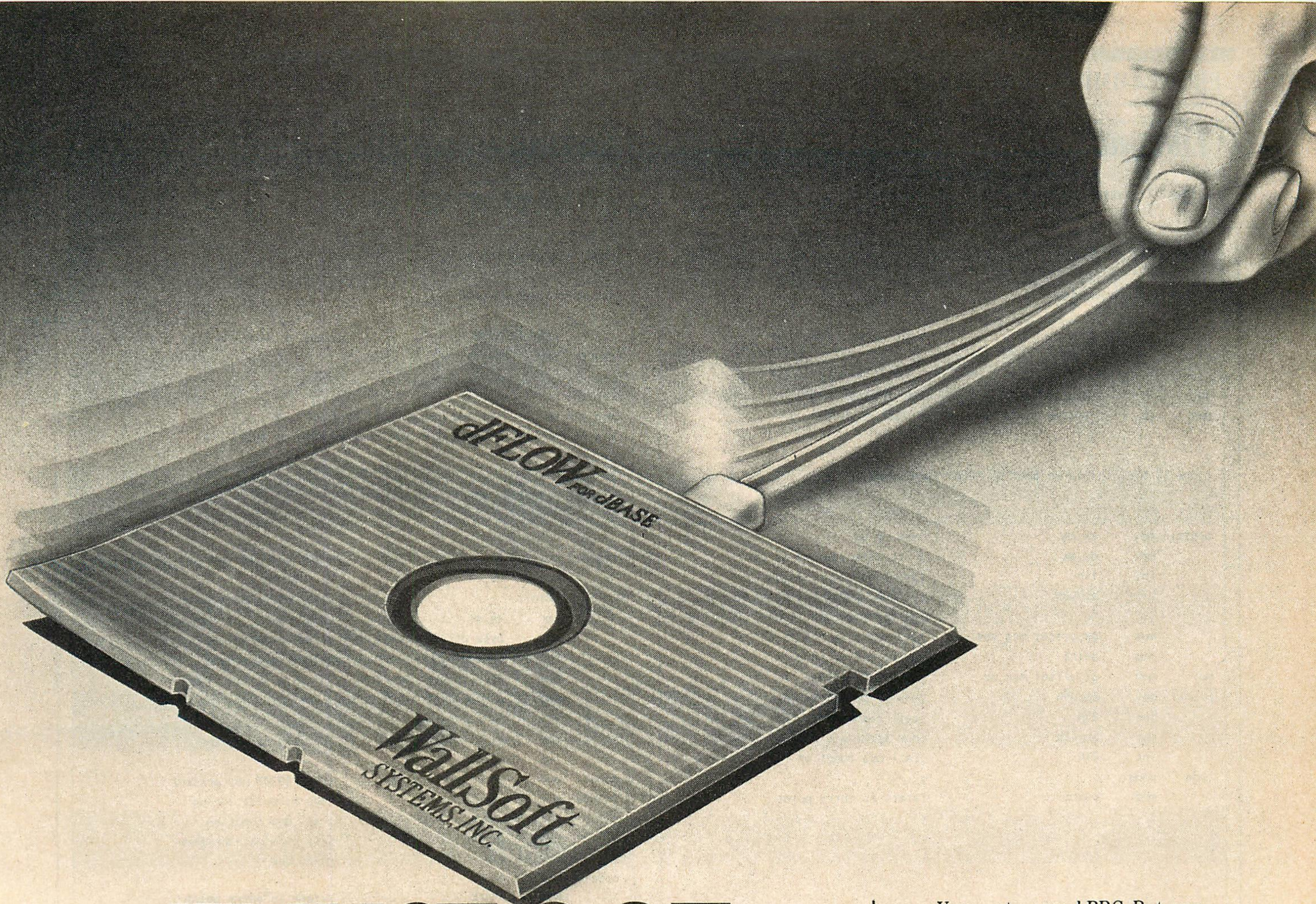

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LISTING 3: MATHSWIT.ASM

```
;
; Check if system switches set for math coprocessor
;

code    segment public

assume cs:code,ds:code

        org     100h                    ;set up as a COM file
start:  jmp     begin

msg_yes db      'System switch set for 8087 or 80287','$'
msg_no  db      'System switch set for no 8087 or 80287','$'

;
; See if bios thinks an 8087 or 80287 is present
;

begin:  mov     ax,cs                   ;set up ds
        mov     ds,ax                   ; to same segment as cs
        int     11h                     ;get bios equip. flags
        test    al,02h                  ;is 8087/80287 bit set?
        jz      no                      ;no means switch is on
        mov     dx,offset msg_yes       ;yes means switch is off
        jmp     print                   ;print yes message
no:     mov     dx,offset msg_no        ;print no message
print:  mov     ah,09h                  ;dos 9: print string
        int     21h                     ;call dos function
        mov     ah,4ch                  ;dos terminate program
        int     21h                     ;call dos function
code    ends                            ;
        end     start                   ;start is entry point
```

LISTING 4: MATHCHIP.ASM

```
;
; Check for math coprocessor
;

code    segment public

assume cs:code,ds:code

        org     100h                    ;set up as a COM file
start:  jmp     begin

control dw      0
msg_yes db      'System has an 8087 or 80287','$'
msg_no  db      'System does not have an 8087 or 80287','$'

;
; test if 8087 or 80287 is present
;

begin:  mov     ax,cs                   ;set up ds to same
        mov     ds,ax                   ; segment as cs
        fninit                          ;initialize math chip
        xor     ah,ah                   ;clear ah
        mov     byte ptr control+1,ah   ;clear memory byte
        fnstcw  control                 ;store control wrd
        mov     ah,byte ptr control+1   ;hi byte is 03h if 8087
        cmp     ah,03h                  ; or 80287 present
        jne     none                    ;
        mov     dx,offset msg_yes       ;8087/80287 present
        jmp     print                   ;
none:   mov     dx,offset msg_no        ;8087/80287 not present
print:  mov     ah,09h                  ;dos 9: print string
        int     21h                     ;call dos function
        mov     ah,4ch                  ;dos terminate program
        int     21h                     ;call dos
code    ends                            ;
        end     start                   ;start is entry point
```


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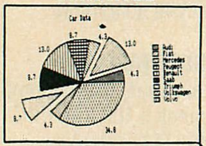

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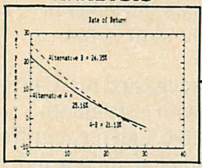

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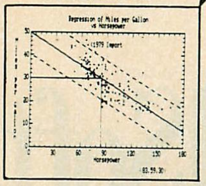

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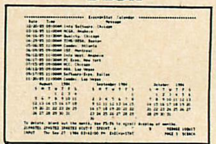

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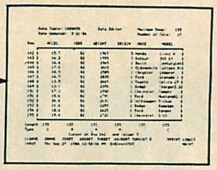

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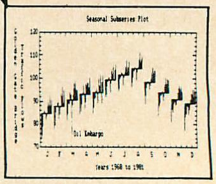

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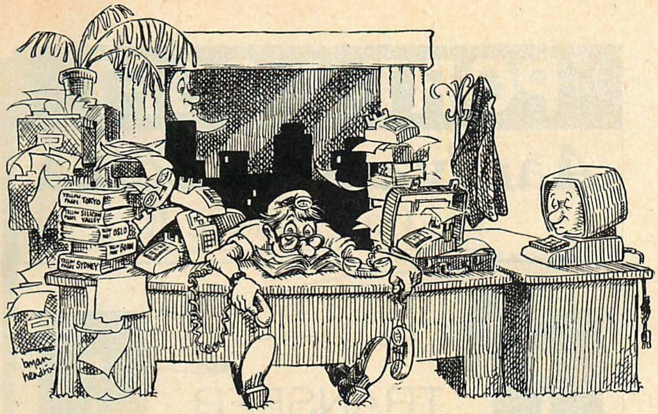

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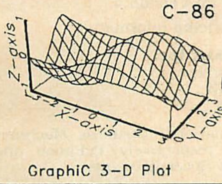

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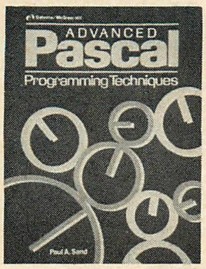
Necessities for Pascal Experts

Serious Pascal programmers should be certain to make this book required reading.

Advanced Pascal Programming Techniques
Paul A. Sand (Osborne/McGraw-Hill, Berkeley, CA 1984)
370 pages; paper, $19.95



Books such as this one, which is to say books for Pascal experts rather than Pascal students or Pascal dabblers, are rare enough—*good* books like this one are pearls beyond price. Most Pascal books simply describe the language, give a few examples, and say good-bye. Few authors dare to assume that the reader knows Pascal well enough to dispense with that and bring the big guns to bear on some difficult programming problems.

That is Paul A. Sand's approach in his book, *Advanced Pascal Programming Techniques.* While the book is not specifically about Pascal on the IBM PC (real-machine examples, when given, involve the Apple II), the material is sufficiently general and sufficiently unique to merit a look by serious Pascal programmers on any IBM product.

Sand begins the book with a short chapter on what a good program should be. Practical rather than theoretical, his considerations are driven by the needs of users rather than adherence to any particular theory. This is *not* a book on program analysis or design.

The next two chapters build a toolkit of functions and procedures for handling interactive input, string/number conversions, and output formatting. In the process Sand builds GASLOG, a simple program for logging gasoline usage on trips, and as good an example of a simple record-oriented file manager as can be found.

The easy material ends with GASLOG. In the next chapter Sand dives into the subject of command parsers by designing a general purpose pocket calculator emulator that can handle parentheses, roots, scientific notation, and named variables. A fascinating program with useful ideas, it includes an "extended real" type with greater range and precision than Turbo Pascal's real numbers. The only disappointment (and much of the book inherits this flaw) is that Sand fails to discuss how the routines can be generalized or customized for application in programs other than calculator emulators.

The next chapter generates some text file tools that are too tied to the Apple II (including dropping into 6502 assembly language) to be of much interest to the IBM PC programmer.

The following chapter on game theory is much more interesting. In devising an implementation of the game Reversi, Sand covers alpha-beta game tree pruning. This is one of the best and most generalized discussions in the book; the method shown could be implemented in many languages as well.

The following chapter, on simulation and animation, presents some fascinating theory. Although complicated by some Apple II graphics library references, the theory can be translated readily into Turbo Pascal for IBM graphics. The two example programs simulate bouncing rubber balls and a pair of objects affected by mutual gravitational attraction. Some of the math gets deep here, but it is to Sand's credit that I followed and understood.

The last chapter in the book is the longest, heaviest, and by far the best. It describes the workings of a simple electronic spreadsheet. Sand's PASCALC is similar in some ways to the toy spreadsheet program included with Turbo Pascal and is much easier to understand. Sand handles the non-trivial notion of sparse matrices with aplomb and some well-conceived diagrams. He covers every last detail on spreadsheet function, leaving absolutely nothing "as an exercise for the reader."

This book approaches the subject from the details up rather than from the theory down. A close reading will give a fairly complete understanding of each problem. I felt a lack of a view "from on high," however, and I am not certain how thoroughly I could apply the broader concepts to problems unrelated to those in the book. Sand is evidently expert enough to extract that big picture from his close understanding of code details. Many of us, still on our way to becoming experts, could use a little help.

One other problem is the author's response to problems with code speed. His first impulse in almost all cases is to drop into assembly language rather than examine possible "tricks" in Pascal that might violate the spirit of the language. If portability is his motivation I am puzzled; nothing is less portable than assembly language. In a modern, heavily extended Pascal like Turbo Pascal, a *lot* can be done to improve the code speed of traditional approaches without resorting to assembly language. Perhaps Sand felt that his example machine (the Apple II) was so slow that he had no other choice. The same cannot be said of the IBM PC family.

On the other hand, there is a gold mine of Pascal code here, and superb discussions of game theory, interactive input, scientific simulation, and spreadsheet data structures. Can one have it both ways? I am not sure, but after buying a shelf-full of books long on theory and short on detail it is a relief to find a book that gives the details the attention they deserve. Along with Cortesi and Cherry's *Personal Pascal* (Prentice-Hall, 1984), this is certainly one of the finest Pascal books I have ever read, and it belongs at the fingertips of every serious Pascal programmer.

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Exporting Technology

Because of complex regulations from the Commerce Department, the export of technical data is not for amateurs.

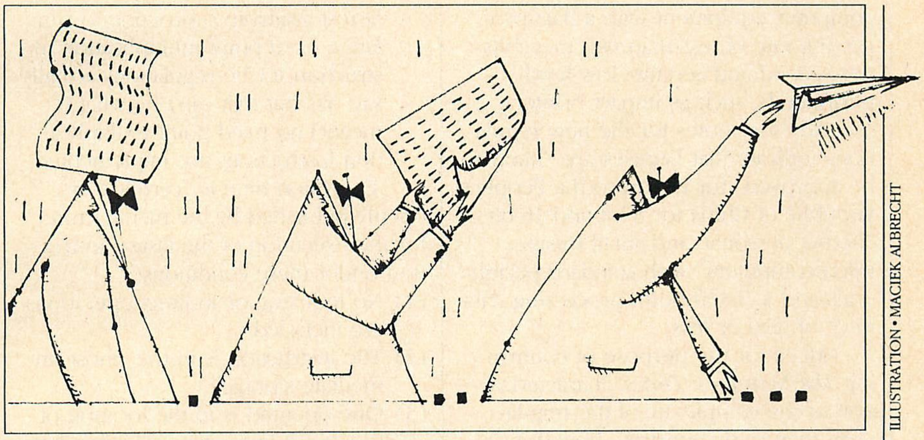
The signs are unmistakable that personal computer manufacturing capacity exceeds domestic demand. The loss of Osborne could be discounted as an isolated incident. The demise of Adam could be viewed (perhaps even with pride) as evidence that personal computers are not toys. The temporary closing of plants by Apple might be attributed to earlier excess enthusiasm. But the end of the PC*jr* is serious.

Surely there must be some underdeveloped country (that still uses half of its domestic power production to run its IBM 7044s) that would jump at the chance to upgrade its technological base. Why have computer manufacturers not developed those markets? How could it be that *The New York Times* could report on February 8, 1985, that the Soviet Union was *for the first time* negotiating for the purchase of personal computers from the West?

The answer may lie in a set of U.S. Commerce Department regulations, which make it difficult to export computer technology.

Under the regulations, "the export from the United States of all commodities, and all technical data . . . is . . . prohibited unless and until a general license authorizing such export shall have been established or a validated license or other authorizations for such export shall have been granted. . . ." The authority to regulate exports was originally created by the Export Control Act of 1979 (50 USCA Sec 2401 et seq). The Export Control Act expired on September 30, 1983, but has been extended by Executive Orders on October 14, 1983, and again on March 30, 1984.

Legal issues could be raised about the validity of the restrictions, but a challenge would most likely be time-consuming and costly, and the national purposes behind the restrictions are powerful: national security, the furtherance of U.S. foreign policy, and the protection of the domestic economy from



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the excessive drain of scarce materials. The third purpose clearly does not apply to 8-bit computers.

Whether an export of a commodity has taken place or not is largely self-explanatory; the concept of export of technical data is more subtle. Under the regulations, export of technical data takes place when there is a transmission out of the U.S. or a release of technical data in the U.S. "with the knowledge or intent" that it is to be transmitted to a foreign country; or a release in a foreign country of technical data of U.S. origin. The regulations specifically provide that export of technical data may take place through:

(1) visual inspection by foreign nationals of U.S.-origin equipment and facilities;
(2) oral exchanges of information; or
(3) the application to situations abroad of personal knowledge or technical expertise acquired in the U.S.

Thus, such seemingly "non-export" activities as giving a plant tour, filing a foreign patent application, or handing out lecture notes at a foreign symposium fall within the scope of the regulations. In a guidance document issued under the regulations, the Export Administration has taken the position that:

(1) providing technical advice over the telephone to a foreign customer is an export of technology and thus cannot go beyond what is contained in the manuals sent with the equipment under an export license; and
(2) the installation of equipment by technicians is likewise an export of technology and, therefore, the techniques used (whether demonstrated to the foreign customer or not) are subject to similar constraints.

The degree of control exercised over exports depends on the type of commodity and the destination country. At the ends of the spectra are toaster ovens and nuclear technology; and Canada and North Korea.

Licensing requirements range from the so-called "GDEST" license for hardware (and the "GTDR" license for technical data), which is available if certain requirements are met and which requires neither an application nor the issuance of any formal permission, to "validated" licenses, which do require the filing of an application and the issuance of approval before shipment. Failing to comply with applicable licensing requirements can result in criminal penalties, seven-figure fines, and the loss of export privileges.

Prior to 1985, most computer equipment required a validated license. On December 31, 1984, the Commerce Department's Office of Export Adminis-

tration published what *The New York Times* described as a "complex, 24-page set of new rules which have caused widespread confusion in the industry." Those regulations relaxed licensing requirements for hardware but increased them for software. On January 31, 1985, the administration delayed the effective date for those regulations restricting the export of software, reportedly to allow exporters more time to comply (although it is possible that the administration is reconsidering the restrictions on software). The regulations decontrolled shipment to most countries of most computer equipment with a data processing rate of less than two megabits per second and certain "low-level" peripherals, such as impact printers.

Advisory notes for the new regulations indicate that licenses are "likely to be approved" for export to the People's Republic of China for 8-bit and 16-bit "home, personal, and small business microcomputers" with standard peripherals and a "fixed point processing data rate" of 26.0 or less.

More for the purpose of confirming *The New York Times'* characterization of the complexity of the regulations than to demonstrate how the regulations work, here is the Commerce Department's definition of "fixed point processing data rate":

The sum of
(1) 0.85 times the number of bits in a fixed addition instruction;
(2) 0.15 times the number of bits in a fixed point multiplication instruction; and
(3) 0.15 times the number of bits in a fixed point operand

divided by the sum of
(1) 0.85 times the execution time for a fixed point addition; and
(2) 0.15 times the execution time for a fixed point multiplication or for the fastest available subroutine to simulate a fixed point multiplication instruction if (the regulations actually say "is" but that can't be what is meant) no fixed point multiplication instructions are implemented.

Execution time is "certified or openly published by the manufacturer" for the execution of the fastest instruction under these conditions:
(1) No indexing or indirect operations are included.
(2) The instruction is in the "most immediate storage".
(3) One operand is in the location of the "most immediate storage" that is acting as the accumulator.
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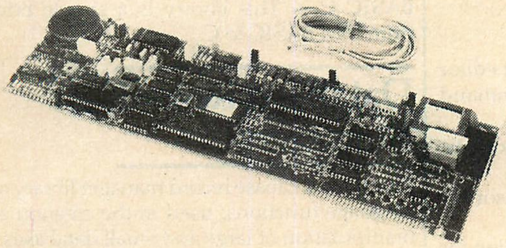

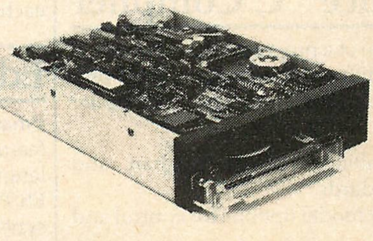

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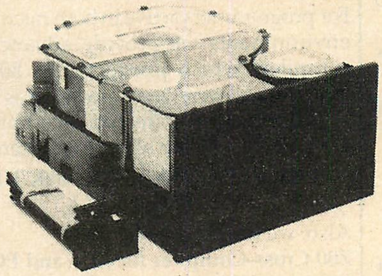

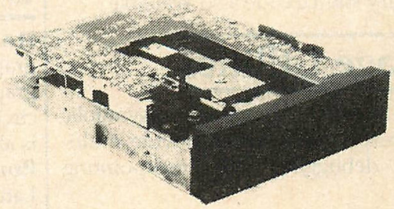

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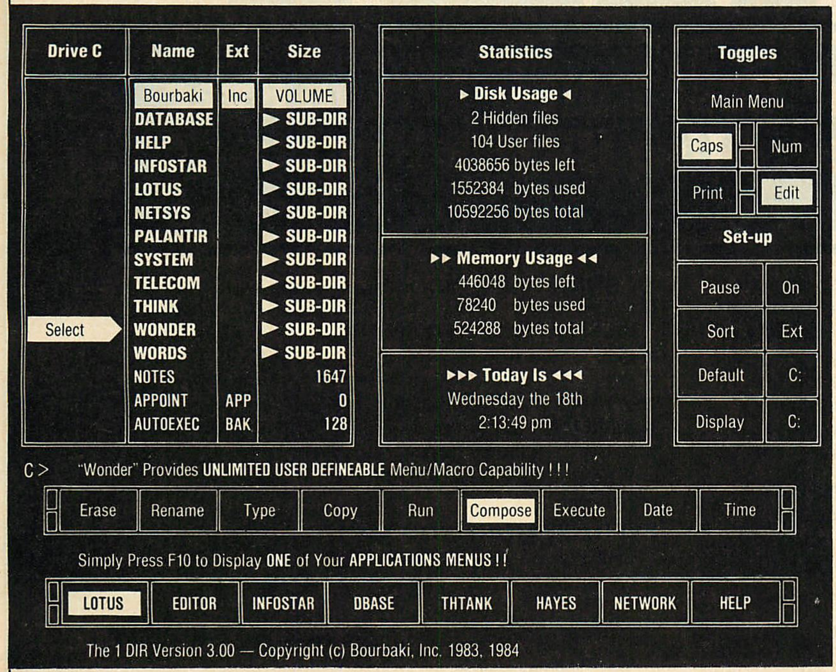

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```
═══════════════════════════ make.c ═══════════════════════════
int       handle = 0;

main (argc, argv▮

int            argc;
════════════ fsa.h ═══════════════════════ makefile.h ═══════
#include "..\include\ctype.h"          |/**
                                        | **          makefile.h:
typedef  struct                         | **
{                                       | **      This is the definitions fil
   short    action,                     | **   Hopefully, it won't be unreasonab
            state;                      | **   that have been written.
} Fsa;                                  | **/
#ifdef   FSA_MAIN                       |
Fsa      fsa[][8] = {/* Alphanum     Co |typedef struct cmd_struct
                                        |{
/* State 0. */          0, 2,        10 |  char        *cmd_text;
/* State 1. */          10, 0,       10 |
/* State 2. */          0, 2,        1, |  struct cmd_struct *next_cmd;
/* State 3. */          0, 5,        11 |} *Cmd_Ptr, Cmd;
/* State 4. */          0, 4,        0, |
Mismatched open parenthesis.            Line: 11   Col: 17      2:17 pm
```

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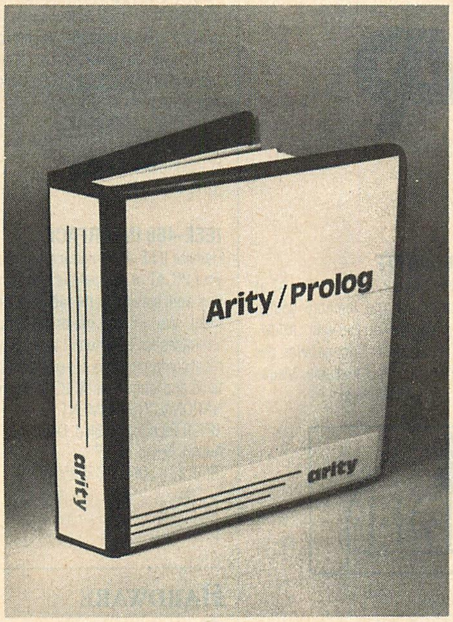

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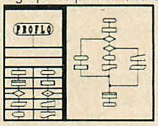

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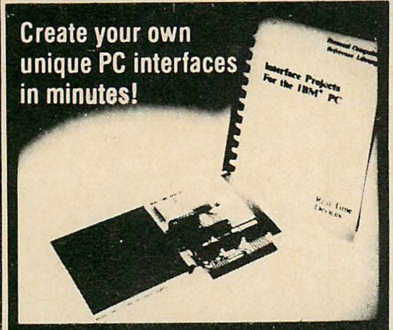

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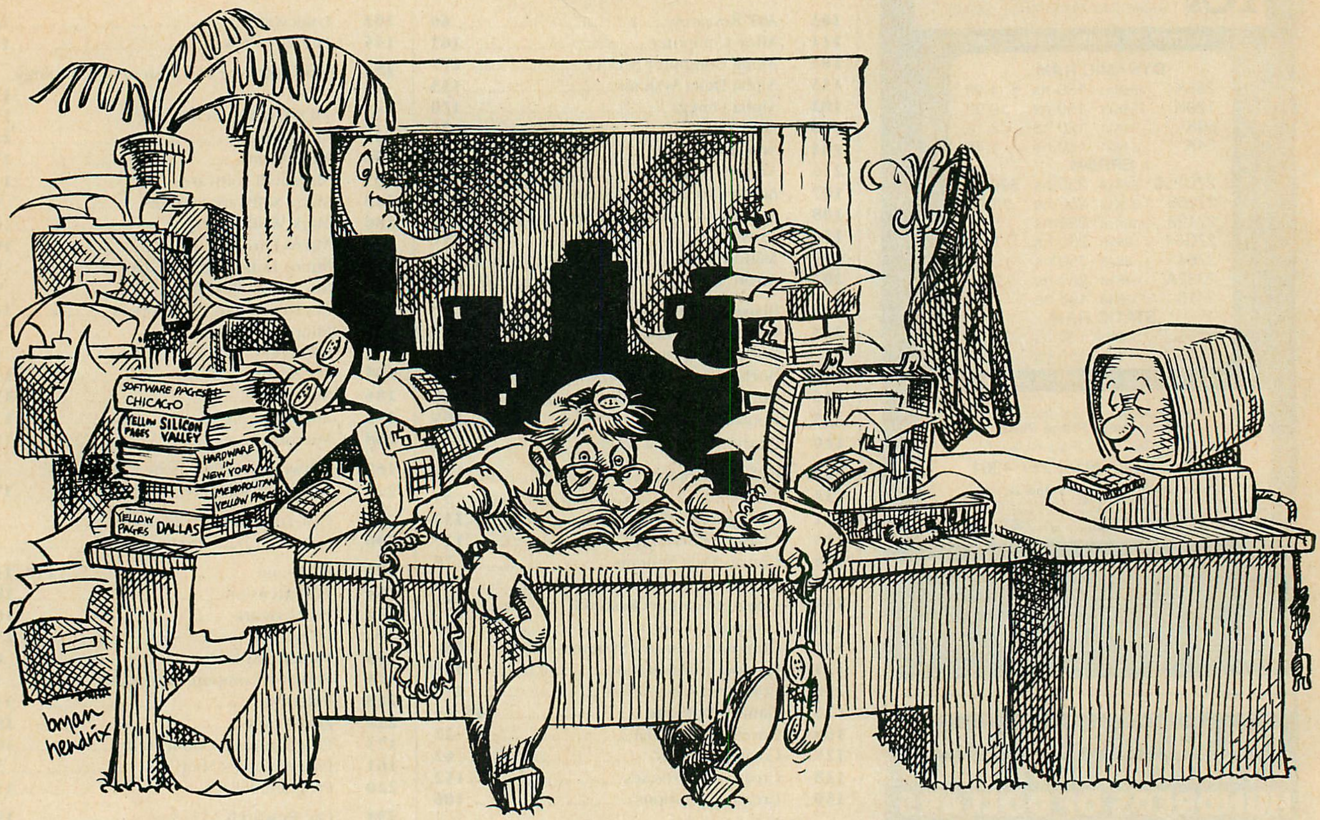

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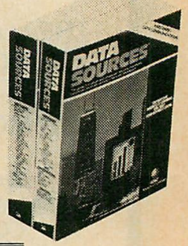

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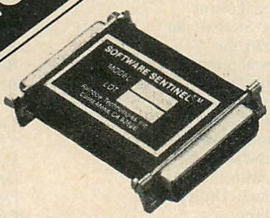

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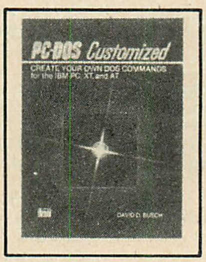

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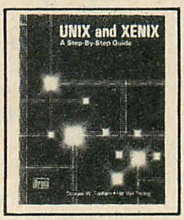

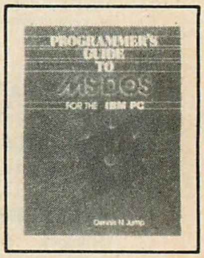

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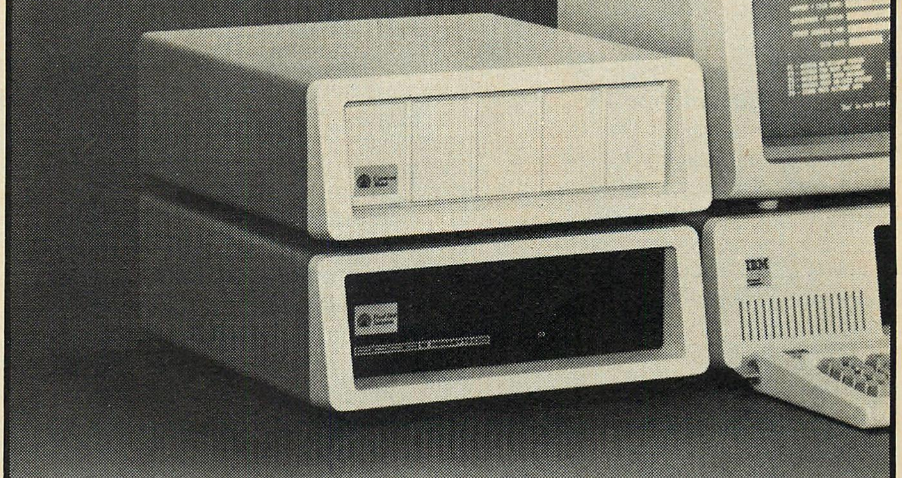

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Forward Word/Backward Word
Beginning of Line/End of Line
Scroll Up/Scroll Down
Window Up/Window Down
Scroll Left/Scroll Right
Top of File/Bottom of File
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Block Commands

Copy/Move/Delete
Read/Write
Lower Case/Upper Case
Fill/Justify
Print

File Commands

Directory (with wild cards)
Show File/Help File
Input/Output File
Delete File/Save File

Other Commands

Split Screen/Other Window
Find String/Replace String
Replace Global/Query Replace
Delete Line/Undelete Line
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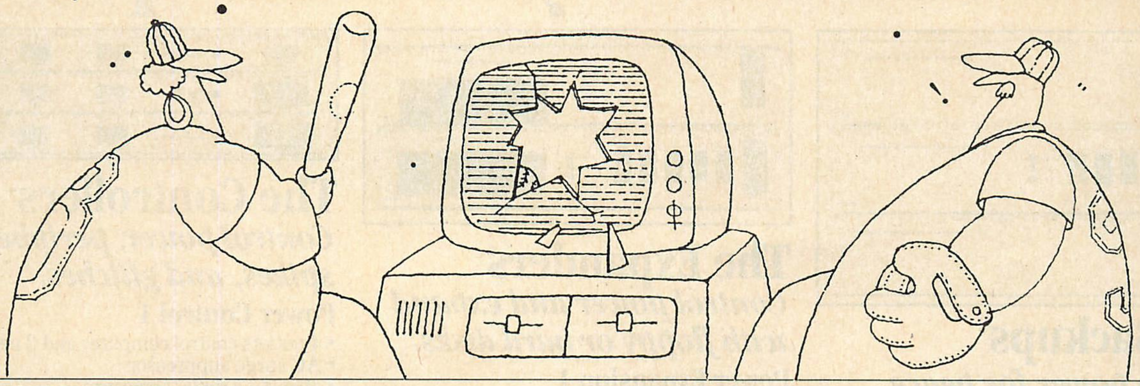

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June 24-26
Videotex '85—Fifth Annual Industry Conference and Exhibition
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June 25-28
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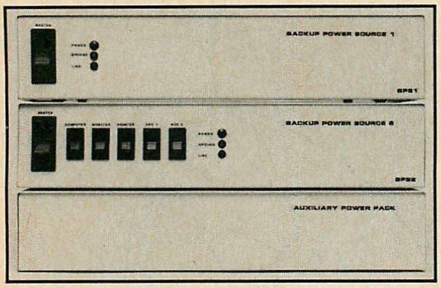

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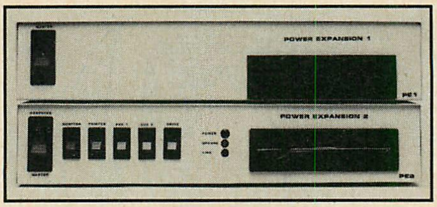

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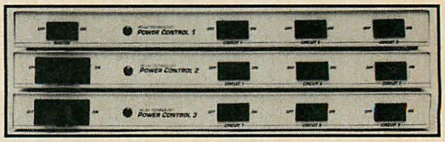

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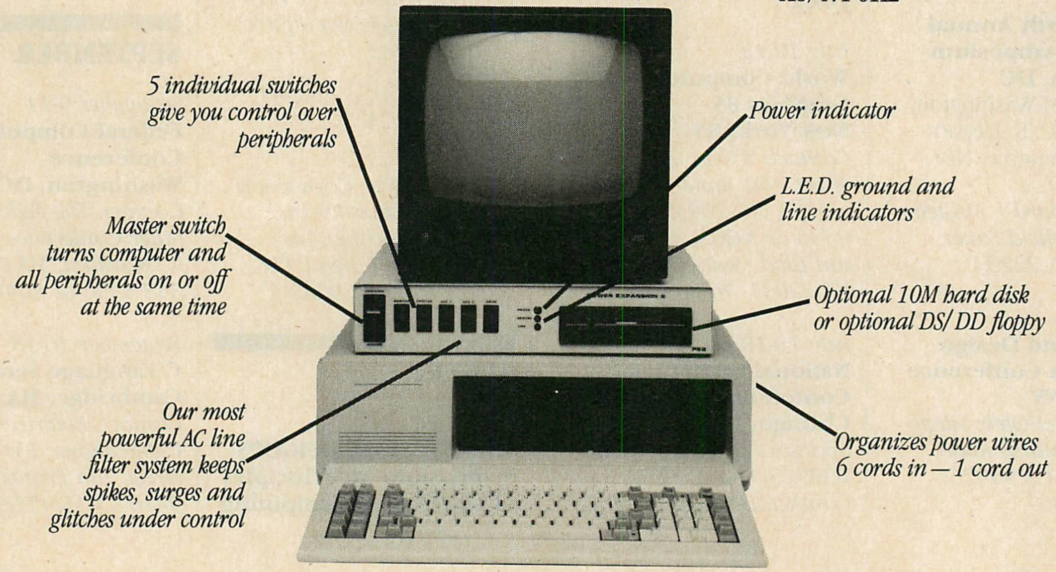

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